

वार्षिक प्रतिवेदन **Annual Report**

2008 - 2009



केन्द्रीय अंतरर्धलीय मात्स्यिकी अनुसंधान संस्थान
Central Inland Fisheries Research Institute
(Indian Council of Agricultural Research)

Barrackpore, Kolkata - 700120





ANNUAL REPORT

2008 – 2009



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ANNUAL REPORT 2008-2009

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PREFACE

During the year, CIFRI pursued its mandated research agenda to generate scientific information to understand in detail the production functions of inland waters, viz. rivers, estuaries, wetlands and reservoirs that would help in formulating management action plans. The research was also directed towards standardizing and application on pilot scale the enhancement tools to improve the fish productivity in reservoirs and wetlands. Work was also carried out to use modern tools of remote sensing in order to develop digitized maps of inland water bodies of 0.5 ha in area and above covering as many states in a phased manner. While looking at issues involving inland aquatic environment and climate change, the Institute actively monitored ecosystem health and assessed the impacts on fish stocks at molecular, physiological and community levels. The contamination of inland aquatic food chain, including fishes, by various toxicants and their degradation were also looked into. All these programmes have generated valuable scientific information during the year and we share this with our readers. Apart from research carried out under institute based projects, work was also carried out in three out-reach projects, a number of sponsored projects and consultancies during the year. We are also associated with execution of three NAIP programmes as consortium partner. The Institute further strengthened linkages with different research institutes, and also established project linkages with Damodar Valley Corporation, Central Pollution Control Board, National Fisheries Development Board, Govt. of Madhya Pradesh, Jharkhand, Uttar Pradesh, Haryana & Gujarat in different reservoir and environment related investigations. One international project 'Challenge Programme on Water and Food' sponsored by CGIAR on reservoir fisheries in collaboration with WorldFish, Malaysia and International Water Management Institute, Sri Lanka was successfully implemented. During the year CIFRI took many HRD initiatives, infrastructure development and organizational re-structuring as well.

All the achievements highlighted in this report are the outcome of the sincere efforts made by all members of

staff of CIFRI located at Barrackpore (Head Quarter), Allahabad, Bangalore, Guwahati, Kochi and Vadodara for which they deserve appreciation, but there is always a scope to improve our individual and collaborative programmes further. I am confident that in future too CIFRI staff will execute the mandated activities of this institute with renewed dedication and commitment.

I express my sincere thanks to Dr. Mangala Rai, the Secretary DARE & D.G., ICAR for his overall support and encouragement to the activities of CIFRI. The administrative support at the Council level provided to CIFRI by Shri A.K. Upadhyay, IAS, Additional Secretary DARE & Secretary ICAR is thankfully acknowledged. I am grateful to Dr. S. Ayyappan, DDG (Fy.), ICAR for his guidance and continued support in furthering the research activities of this Institute. Time to time support provided to this Institute by the Fishery Division of the Council, especially Dr. V.V. Sugunan (ADG, I. Fy.), Dr. U. Moza (Pr. Scientist) and Shri Anil Agarwal (Pr. Scientist) and Smt. Kamala Bisht, Under Secretary is thankfully acknowledged.

This brief report of CIFRI, I am hopeful, will be useful to various persons and organizations, involved in inland open-water fishery and ecosystem management to achieve the objective of sustainable fishery and biodiversity conservation.

I am thankful to Dr. Manas Kumar Das, Head, Fishery Resource and Environmental Management and Dr. Sanjib Kumar Manna, Senior Scientist in compiling the basic draft of the document and to all other colleagues who have extended their help. Shri P.R. Rao (Asst. Director, OL) and his staff members rendered their assistance in Hindi summary, which is duly acknowledged. The institutional administrative and financial co-operation extended to scientific activities by Shri U.C. Prasad, SAO and Shri Z.H. Khilji, FAO is duly acknowledged.

Barrackpore, Kolkata
August, 2009


K.K. Vass
Director



EXECUTIVE SUMMARY

The Central Inland Fisheries Research Institute (CIFRI) through its dedicated service in inland fisheries sector over the years has established itself as a premier institute in the country and has made a place at international level as well. The Institute is located at Barrackpore, Kolkata in the State of West Bengal. Out of total sanctioned cadre of 98 scientists, 90 technical, 80 administrative and 168 supporting staff, forty nine scientists, eighty one technicians, sixty five administrative staff and one hundred and twenty eight supporting personnel served the institute during the period 2008 - 09. The CIFRI had a total budget allocation of Rs. 12.99 crores for the year 2008-2009, which was effectively utilised.

The Institute organized its research programmes keeping in view the guidelines of the high level Research Advisory Committee (RAC) and recommendations of the recent Quinquennial Review Team (QRT), and the road map indicated in our VISION 2025 including the thrust areas identified for CIFRI in XI Plan EFC. The Institute also has a Management Committee guiding its activities. A number of internal committees such as Institute Research Committee, Institute Joint Staff Council, Official Language Committee, Consultancy processing cell etc., are in place and contributed to Institute's management activities through periodic meetings and consultations.

The Institute during the year 2008-09 focussed its attention on overall performance that involved executing projects that are institute based, sponsored, contract research, and consultancies. At the same time serious attention was given to transfer of technology, internal and external human resource development, public awareness programmes, establishment of linkages, and institution building activities.

The research programmes were designed with major thrust on ecosystem research involving resource assessment, ecology, biodiversity, fish stock evaluation including yield improvement and environment monitoring and its management. During the year, the Institute worked on eight

research programmes, involving thirty one project activities, apart from six externally and one internationally funded projects. Salient achievements findings under various programme areas are highlighted as under:

Riverine Fisheries

- The Delhi-Etawah stretch of river Yamuna reflected deterioration of water quality. Although this stretch seems to be most productive but it is not now congenial to endemic species as the niche at present is being utilized mainly by exotic *Tilapia*, which is now gaining strong foothold in the area. Earlier in this stretch major carps and large catfishes used to contribute around 75% but now their contribution has reduced to 15-20%.
- Examining the issue of proposed river links approved by the government, the work carried out by CIFRI indicated that abiotic and biotic parameters of the rivers Ken and Betwa did not reflect any significant difference. On the basis of secondary data, Betwa harbours fish diversity (58) as compared to Ken (53). Presence of *Tilapia* and *Cyprinus* sp. was recorded from both the rivers.

Reservoir Fisheries

- Three reservoirs giving low fish yields viz., Karapuzha and Kanhiraphuza (Kerala), and Arjunsagar in Uttar Pradesh were investigated and CIFRI technology is being implemented for improvement.
- In Suvarnavathy reservoir, Karnataka, a total catch of 45.1 t was recorded during February 2008 to January 2009. Indian major carps contributed a high of 93.8% to the total catches with the rest mainly by *tilapia*. The mean CPUE recorded a high of 11.5 kg. with high fish yield of 123.4 kg/ha.
- In Kanhiraphuza reservoir, the low yield was due to improper stocking practices such as over stocking at fry stage seed.
- A static mass balance model of the Kelavarappalli was developed using Ecopath software to analyse

the foodweb ecology and ecosystem properties of the reservoir. The biomass (t/km^2), production/biomass of the fish groups were estimated and used as input parameters for the model.

- Models were developed for reservoirs after categorizing them into low and high yielding reservoirs. Reservoir data collected from the states of Karnataka, Tamil Nadu, Rajasthan, Andhra Pradesh and Madhya Pradesh were then used to estimate the relationship of yields with mean-depth and area of the reservoir.

Estuarine Fisheries

- In Godavari estuary alarming decline in mullet fishery to the tune of >98% has been estimated as compared to 1980s. There has been a sharp decline in Hilsa fishery, from 231 t (1980s) to merely 7 t (2008). A total of 110 fish species, 14 species of prawn and 6 species of crabs have so far been recorded.
- In Subarnarekha estuary the fishery is dependent largely on prawn (*M. monoceros* & *M. brevicornis*) and small mullets (estuarine stretch) and *L. calbasu* & *M. rosenbergii* (freshwater stretch). A total of 109 species of fish and 13 species of prawns have so far been recorded.
- The fisheries of Pulicat lake reveal changing trends. The dominant fishery at present is *P. indicus* (>50%) followed by mullets (20%). *Chanos chanos* and green crab *S. serrata* fishery has declined. *O. mossambicus* has established (9-12%). The decline over time is ascribed to over fishing by destructive nets and wanton killing of mature brooders.

Wetland Fisheries

- Seventy nine species (9 exotics) of fin fishes under 57 genera and 32 families have been identified from eight wetlands of different categories in Ganga river basin. Fish diversity (Shannon index H') ranged from 1 to 2.5 amongst all the categories of wetlands studied with higher diversity in wetlands having permanent riverine connection. The catch of natural fish stock ranged from 0.1 to

0.4 t/ha/year and the CPUE ranged from 0.9 to 9.4 kg/fisher/day with higher CPUE from wetlands having permanent riverine connection.

- To standardize the stocking density in cages, fingerlings of major and minor carps (*L. rohita*, *C. mrigala* and *L. bata*) were stocked at densities of 20, 30, 40 and 50 per m^3 in eight cages having mesh size of 1 mm. The growth increment recorded a significant fall at higher stocking density of 50/ m^3 .

Fish Health & Environment

- The total organochlorine pesticide residues (including HCH, DDT, endosulfan, aldrin, dieldrin, endrin, heptachlore and their metabolites) analyzed in the river Damodar registered occurrence of DDTs in the range of 22.0-33.38 ng l^{-1} in water, the levels are sufficient to stress aquatic organisms including fish and impacting their biology and physiology.
- A rapid fluorometric protocol based on 96-well microplate format was developed for estimation of water and sediment phosphatase and β -Glucosidase enzyme activities in aquatic environments using low amount of sample and fluorogenic substrates.
- Nineteen bacterial isolates resistant to phenol, 2,4-dichlorophenol, 4-methyl-chlorophenol, pentachlorophenol and resorcinol have been isolated from polluted river stretches of river Damodar. Initial study indicated phenol degrading ability of few isolates tested so far. Further studies are in progress for selecting the best suited microbe for bioremediation.
- A perceptible shift in geographic distribution of the warm water fish species *Glossogobius giuris*, *Puntius ticto*, *Xenentodon cancila*, *Myxus vittatus* towards the colder stretch of the river Ganges around Haridwar has been recorded. With an enhancement of annual mean minimum water temperature by 1.5°C in the Haridwar stretch during the period from 1970-86 to 1987-2003 the stretch of river Ganga around Haridwar has become a congenial habitat for these warm water fish species.



Fishery Resource Assessment

- For development of digital map of inland water bodies of the country using remote sensing satellite data, water bodies of 0.5 ha and above were identified and mapped using LISS III and PAN imageries initially for three states, namely, Punjab, Haryana, and Orissa.
- The mapping of water bodies with area above 10 ha was completed in the state of Madhya Pradesh using post monsoon data.
- The ground-truthing was undertaken in 27 districts in Orissa and Uttar Pradesh for the verification of imageries with physical verification of the water bodies.
- Spatial and other information has been attached with GIS format. Significant correlation was established between remote sensing data and water chlorinity & salinity in IR, red and green bands for Purulia watershed. Murugama (Sahara Jore) watershed in Purulia district of West Bengal was delineated and digitized for first, second and third order streams of the water shed.
- Digital Elevation Model, catchment area and streams were delineated for four water bodies namely i) Hunumata Dam ii) Tilaitanr Bundh iii) Kumari Dam iv) Muruma Bundh. Land use map for four catchment area were also created using LISS III imageries.

Other projects

Apart from the institutional projects, the work was also executed under the following sponsored projects:

DAHD & F (Govt. of India) project

- Strengthening of database and information networking for fisheries sector

ICAR Cess fund

- The Ecology and Management of Aquatic Weeds in Ganga and Brahmaputra basin with particular reference to Fisheries enhancement
- Popularisation of Organic Farming approach in Fisheries for Sustainable Development

ICAR Network project

- Adaptation and vulnerability of Indian agriculture to climate change – Effect of climatic change on inland fisheries

CGIAR (Challange Programme on Water & Food)

- Improved fisheries productivity and management in tropical reservoirs in Indo-Gangetic Basin Nile and Volta Basins.

NAIP project

- Arsenic in food chain: Cause, Effect and Mitigation.
- Sustainable livelihood improvement through need based integrated farming system model in disadvantaged districts of Bihar.
- Toll-like Receptors in Phylogenetically Divergent Fish Species - Their Contribution in Modulating the Innate Immunity.

CPCB/CIFRI project

- Assessment of fisheries with regard to water quality of the river Ganges and Yamuna.

OUTREACH activities

- Feed for carp culture in cages and pens.
- Nutrient Profiling and Evaluation of Fish as a Dietary Component
- Outreach activity on fish genetic stocks.

Other activities

The meeting of the various committees of the Institute viz., Institute Research Committee, Research Advisory Committee, Institute Management Committee, Official Language Committee, Institute Joint Staff Council were held as per schedule. The respective committees discussed various agenda items and provided guidelines for the proper management and smooth functioning of the Institute and execution of research activities.

The CIFRI family is representative of the diverse cultures of the country and each member participated in celebration of the national importance viz. Independence Day and Republic Day with genuine spirit of harmony and brotherhood. Apart from these staff members celebrated, Anti-Terrorism Day on 21st May, Sadbhawana Diwas on 20th August and Quami Ekta Diwas on 19th November.

INTRODUCTION

Brief History

Based on the recommendations of sub-committee of the Central Government on Agriculture, Forestry and Fisheries the Central Inland Fisheries Research Station was formally established on 17 March 1947 in Calcutta under the Ministry of Food and Agriculture, Government of India. From this modest beginning, the station expanded its activities and was elevated in 1959 to the status of an Institute (CIFRI) and moved to its own building at Barrackpore (West Bengal). Over the years, the organization has grown & established itself as a premier research institution in the field of the inland fisheries and aquatic ecology in the country. Since 1967, the Institute is under the administrative control of Indian Council of Agricultural Research (ICAR), DARE, and Govt. of India.

Initially the main objective of this Institute was to conduct investigations for a proper appraisal of all inland fishery resources of the country and to evolve suitable methods for their optimum fish production. While fulfilling the above objective, the Institute directed its research efforts towards understanding the ecology and production functions of different types of inland water bodies in the country. But investigation were also conducted to understand pond ecosystem, its bearing on fish production which eventually lead to development of farming practices to obtain high fish yield from unit of water area.

The Institute during late sixties and seventies focussed its attention on aquaculture research and development in consonance with the plan priorities of Government of India. Having achieved significant progress in fishery research & farming practices in the country, the planners between 1971-1973 approved All-India Coordinated Research Projects, one each on "Composite Fish Culture". "Riverine Fish Seed Prospecting", "Air-breathing Fish Culture" and "Ecology and Fisheries Management of Reservoirs" and "Brackish water Fish Farming". The success of combined

project of "Composite Fish Culture & Fish Seed Production" initiated in 1974 was the turning point in the history of fish culture in India and provided a solid foundation for the development of freshwater aquaculture in the country. This resulted in the establishment of the Freshwater Aquaculture Research & Training Centre at Dhauli (Orissa) in 1977, which later became Central Institute of Freshwater Aquaculture (CIFA) in 1987. Simultaneously, Central Institute of Brackish-water Aquaculture (CIBA) and National Research Centre on Coldwater Fisheries (NRCCWF) were carved out from this Institute to carry out research on brackish-water aquaculture and coldwater fisheries respectively. Thus, CIFRI gave birth to three major fisheries research Institutions in the country.

As a consequence of creating specialised institutes and keeping in view the emerging issues like sustainability in open water fisheries and aquatic resource management, the CIFRI mandate was modified.

Our Mandate

- ◆ To undertake basic, strategic and applied research in inland open-water fisheries viz. rivers, reservoirs, lakes, estuaries and associated waters
- ◆ To develop ecosystem-based technology and strategies for productivity enhancement in mandated waters
- ◆ To monitor environmental changes, their impacts on fisheries and developing mitigation action plans in collaboration with other organizations.
- ◆ To create awareness, provide training and consultancy in inland open-water fishery management.

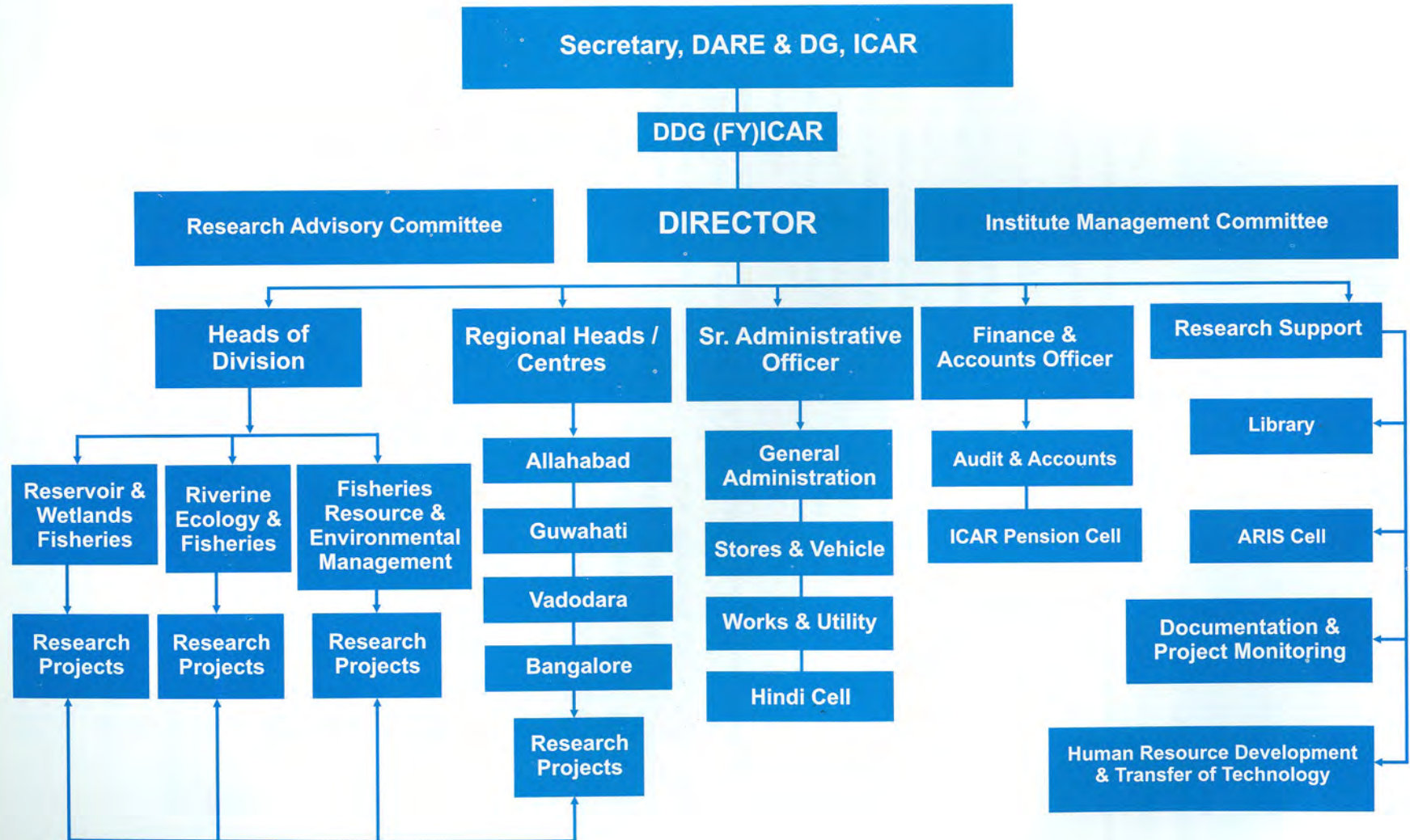
Organizational structure

The institute was pursuing its research activities through different divisions, which are in turn supported by different research support services / sections.



- ☞ The **Riverine Division**, with its headquarters at Allahabad in U.P. strives to monitor and develop effective management action plan for riverine fisheries and resources of the country with adequate emphasis on the conservation of fish stocks & riverine environment.
- ☞ The **Reservoir Division** is based at Bangalore, in Karnataka. The investigations carried out in the Division are aimed at developing management norms for optimising fish yield from large, medium and small reservoirs of the country. The Barrackpore (Kolkata)-based **Estuarine Division** is involved in working on estuarine fishery & ecology, coastal wetlands and sunderban mangrove ecology.
- ☞ The **Fish Health and Environmental Monitoring Division**, is working on fish health and environmental issues related to open-water fishery resources viz., rivers, wetlands, reservoirs and estuaries. It is also looking at biochemical, microbiological, and biotechnological approaches for environment monitoring and management. Development of mitigation action plan for ecosystem restoration is also the responsibility of this Division.
- ☞ The **Floodplain Wetlands Division** carries out research on the wetland ecosystem production processes and fish production enhancement providing special attention to biodiversity conservation and development of environment-friendly technologies.
- ☞ The **Resource Assessment Division** is located at Barrackpore, Kolkata and conducts research aiming at creating a database on the fish stocks and fishery resources. The Division is geared up to develop various population models that leads to sustainable exploitation of inland fish stocks and develop resource management database on GIS format.
- ☞ The **Human Resource Development and Transfer of Technology Division** is located at Barrackpore (Kolkata). The institute has aimed at manpower training and education of fisheries personnel under Human Resource Development. The Transfer of Technology wing undertakes on regular basis the dissemination of various technologies of inland fisheries to the fish farmers, fishermen, entrepreneurs, extension functionaries through training, demonstration, advisory service, fish farmers' day, camp discussion, film show, exhibition, etc.
- Since February, 2009 the institute research activities are organised under three divisions viz., i) Fishery resource and Environmental management division ii) Riverine ecology and fisheries division and iii) Reservoir and wetland fisheries division. The divisional Heads will be the technical head with overall in-charge of the scientific programmes. The regional Heads of the centres of CIFRI at Allahabad and Guwahati will be the administrative heads and look after the implementation of the projects of all the divisions at respective regional centres.
- The Director in Research Management Position heads the Institute. The responsibility of overall management of the Institute lies with Management Committee under the chairmanship of the Director. The Institute Research Committee and the Research Advisory Committee make the specific recommendations pertaining to research and extension activities of the institute. The Institute's research activities are organised under various research projects, which are executed from the headquarters at Barrackpore (Kolkata), and Regional Centres at Allahabad, Bangalore, Vadodara, and Guwahati. The structural outline of the institute is depicted in the Organogram.

ORGANOGRAM OF CIFRI





Research Support Services

Library

CIFRI Library provides services to the scientists of the Headquarters and Centres as well as to the research scholars, teachers and other officials from different organizations. The library added 462 books for the year 2008-09 and subscribed to 17 foreign journals and 25 Indian journals. The current total holdings are 12,006 books, 4316 reprints, 1252 maps and 4344 miscellaneous publications. Complete digitization of books and other materials is under process.

The library maintained free mailing of the Institute's publication to various research organizations, universities, entrepreneurs, and farmers to keep abreast with latest developments. The publication of Indian Fisheries Abstracts was continued. The library has exchange programmes with other National and International organizations.

Project Monitoring and Documentation Section

The section maintained project records through the RPF I, II, and III, prepared Quarterly (QPR) and ICAR/ Dare Reports, processed research papers submitted by the scientists for publications in different journals and for

presentation in symposia/workshops/summer school, etc, monitors the participation of scientists in seminars, symposia, and conferences, *etc.* Furthermore, the section during 2008-09 published ten bulletins, annual report, newsletters, brochures etc.,

ARIS facility

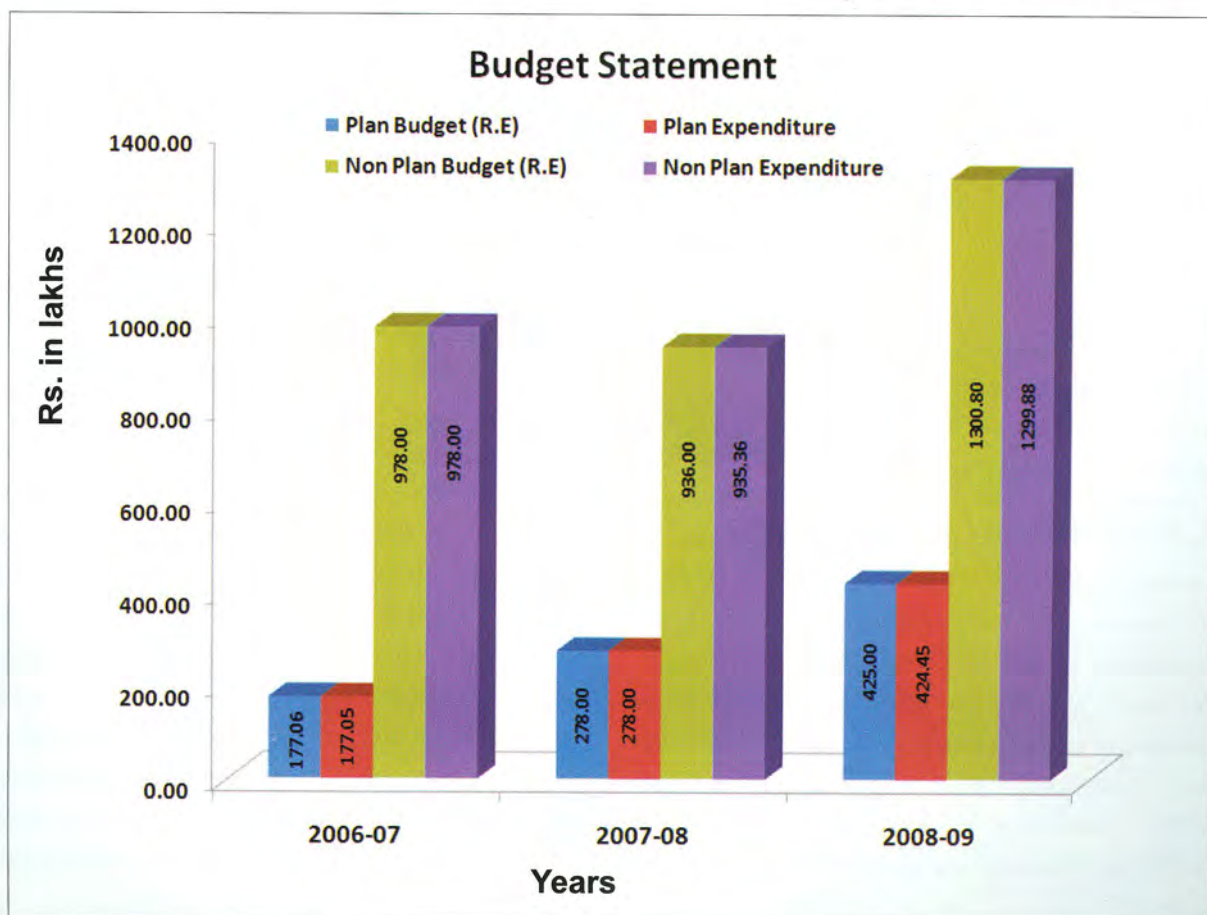
The Institute's ARIS Cell provided the 24-hour 1 mbps internet and Email facilities to the scientists and other staff members with the following services:

- Providing LAN to the main and administrative building with its overall maintenance
- Imparting training to the CIFRI staff from time to time
- Updating Website along with the latest scientific news and information, and with administrative news like tenders and job openings.
- Maintaining centralized antivirus and firewall server to protect the computer and data against malicious activities like unauthorized data access.
- Providing hardware and software solutions through troubleshooting
- Disseminating research findings
- Evolving effective information sharing mechanisms

BUDGET DETAILS

Budget Statement for the year 2008 - 2009 (Rs. in lakhs)

Head of Account	Budget (R.E.)		Expenditure	
	Plan	Non plan	Plan	Non plan
Pay & allowances including OTA	-	1185.60	-	1184.69
T.A.	25.00	5.00	25.00	5.00
Other Charges including equipment, library books, I.T and H.R.D	300.00	90.20	299.45	90.20
Works	100.00	20.00	100.00	19.99
Others	-	-	-	-
Grand total	425.00	1300.80	424.45	1299.88

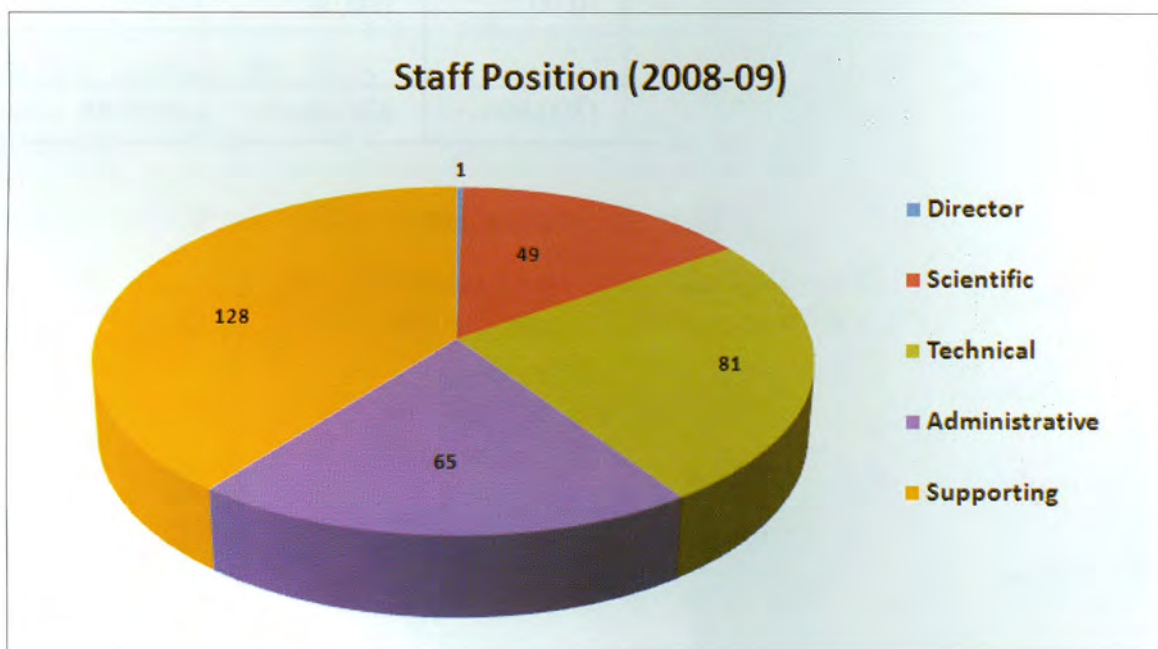




Staff position as on March 31, 2009

Serial No.	Category	Sanctioned	In position
1.	Director (RMP)	01	01
2.	Scientific	98	49*
3.	Technical	90	81
4.	Administrative	80	65
5.	Supporting	168	128
Total		437	324

*Including two (2) Technical Personnel of KVK adjusted against scientific post, as per council's directive.



Existing ratio – S : T : A : SSG

RESEARCH ACHIEVEMENTS

Research achievements during the year 2008-2009 under major programmes areas at CIFRI are given hereunder:

INSTITUTIONAL PROJECTS

RIVERINE FISHERIES

Ecology and fisheries for the Yamuna river

Investigations were carried out at 11 centers on river Yamuna between Badwala and Allahabad (confluence point with Ganga).

Sediment quality: Sediment was alkaline in nature (pH: 7.3-7.5). Specific conductance was maximum at Etawah (926 μScm^{-1}) and minimum at Badwala (402 μScm^{-1}). Sand content was very high in the Badwala – Mathura stretch (84-95%) after which it showed declining trend reaching minimum at Mau (68%). Free CaCO_3 was moderate in the entire stretch (1.36-1.94%). Organic carbon (0.026-0.04%) and available nitrogen (0.46-1.10 mg/100g soil) were poor but phosphorus was quite high (4.2-8.2 mg/100g).

Water quality: The uppermost stretch (Badwala) showed rich oxygen (9.94 mg l^{-1}), alkaline pH (7.7) and comparatively lower values of alkalinity (88.0 mg l^{-1}), conductance (226 μScm^{-1}), dissolved solids (110 mg l^{-1}), hardness (84.0 mg l^{-1}) and chloride (12.07 mg l^{-1}). From Yamuna Nagar due to discharge of effluent and reduction in flow rate the parameters showed increasing trend. The condition became worse between Delhi – Etawah stretch where all the above chemical parameters including dissolved organic matter showed abrupt increase with values between 181.5-219.0 mg l^{-1} , 654-895 μScm^{-1} , 342.5 - 466.3 mg l^{-1} , 219- 279.0 mg l^{-1} and 2.0 – 4.0 mg l^{-1} , respectively. Dissolved oxygen remained low in these stretches (2.0 – 4.0 mg l^{-1}) with high accumulation of carbon dioxide (36.0 mg l^{-1}) and chloride reaching as high as 234.2 mg l^{-1} . The condition of the river improved considerably after the confluence of Chambal and other tributaries below Hamirpur. The nutrient status however remained poor in all the stretches except Delhi – Etawah, where some higher

values were observed (PO_4 : 0.23 – 0.53 mg l^{-1} and NO_3 : 0.36 to 0.58 mg l^{-1}).

Rate of energy transformation by producers: The rate of net energy transformation by producers was minimum at Badwala (1208 $\text{cal m}^{-2}\text{d}^{-1}$) and maximum at Agra (4524 $\text{cal m}^{-2}\text{d}^{-1}$). The rate showed increasing trend from Badwala to Agra after which up to Allahabad ups and down were observed. The higher values at Agra showed positive impact of organic loading in fluvial condition maintained by the discharge from Mathura barrage.

Plankton: Numerical abundance of plankton varied from 50 to 1500 ul^{-1} being minimum at Panipat and maximum at Etawah (mainly *Melosira* and *Navicula* sp). Diatoms remained the dominant component in almost all the stretches whereas green algae contributed significantly at Badwala (32.3%), Mathura (53.2%), Agra (50.1 %) and Hamirpur (36.5 %). Myxophyceae was present in good numbers in Delhi to Lalauli stretch (10.3 to 22.5 %), whereas Euglenophyceae contributed 33.5% in Delhi stretch. Dominance of green algae in Mathura and Agra stretch was due to abundance of chlorococcales or pollution tolerant species. Zooplankton although nil in many centers, contributed significantly at Delhi (29.7 %), Mathura (31.3 %), Agra (14.2 %) and Lalauli (11.1 %), the main components being protozoans, crustaceans and rotifera.

Periphyton: Periphytic abundance ranged between 785 ucm^{-2} (Mau) and 3860 ucm^{-2} (Lalauli). Population was generally higher at Delhi (3557 ucm^{-2}), Agra (2594 ucm^{-2}), Etawah (1950 ucm^{-2}), Lalauli (3860 ucm^{-2}) and Arail (2625 ucm^{-2}).

Benthos: Macrobenthic population was generally poor throughout the stretch ranging between 10 um^{-2} (Badwala) and 120 um^{-2} (Mau). Mollusc were the dominant group in the lower stretch (Lalauli to Mau), as well as Agra and Mathura (during post monsoon). Annelids were the main component in Yamuna Nagar–Delhi stretch and Arail (before confluence). Insect were mainly recorded in Badwala and Yamuna Nagar stretch. Very high abundance of Annelids was recorded during summer at Mathura (300 um^{-2}). *Limnaea* sp, *V. bengalensis* and *Gyraulus* sp. were the main



gastropods whereas Pelecypoda was mainly represented by *Corbicula*.

Spawn availability: Spawn collection was carried out at Maduka (Allahabad) in Yamuna. The index of spawn quantity was 1525 ml and qualitative index 38%, comprising mainly of *L. rohita*, *L. calbasu*, *C. catla* and *C. carpio*. Spawn prospecting investigations in Yamuna at Allahabad resulted in 38% and 1525 ml as qualitative and quantitative index.

Fisheries: Fish landings at Sadiapur and Daraganj were estimated at 88.10 and 39.73 t. At Sadiapur the landings showed a decline of 24% as compared to preceding year. The maximum decline was in common carp which was almost half of the preceding year; however, tilapia landings were almost four times of the preceding year. The increase in catches of tilapia may be a reason for decline in common carp fishery. The others group fishery showed a decline of 26.6%, this may be due to an abrupt change in monsoon cycle. Major carps fishery which started to show sign of revival also declined by 30%. Daraganj centre also showed about four fold increase in tilapia landings, but there was no appreciable change in common carp. Fish landings at Sadiapur and Daraganj were estimated at 88.10 and 39.73 t. Landings at Sadiapur declined by 24% as compared to preceding year, mainly in common carp and others group catches.

In the uppermost zone (Badwala), the catches were dominated by *Shizothorax* and *T. putitora*. In Yamunanagar – Delhi stretch the fishery was mainly composed of smaller species and among exotics only common carp was available. However, at Delhi tilapia was available in good number. A few specimen of thai mangur was recorded at Okhala. In Mathura-Hamirpur stretch the fishery was dominated by tilapia in huge numbers. After Hamirpur, the catches were dominated by smaller species followed by common carp.

Understanding the impact of specific river links on the ecology and production functions

Investigations were carried out in there centers each in Ken and Betwa rivers to develop the pre-linking data base of the rivers.

Sediment quality: Sediment was alkaline in reaction (pH: 7.4-7.6). Specific conductance was lower in Ken (582-651 μScm^{-1}) than Betwa (705-710 μScm^{-1}). Sand content was high in both the river ranging between 82.5 to 85.0% with free CaCO_3 1.3 to 1.9 %. Organic carbon (0.04-0.06 %) and available nitrogen (0.05 to 0.07 mg/100g) were poor but available phosphorus was high (4.8-8.0 mg/100g) in both the rivers.

Water quality: Studies in six stretches, three each in both the rivers, showed that water was rich in oxygen (6.15 to 7.56 mg l^{-1}) with alkaline pH (7.5 to 7.7). Alkalinity, conductance, dissolved solids, hardness and chloride were in the range of 68-85 mg l^{-1} , 169-213 μScm^{-1} , 93-115 mg l^{-1} , 85 to 94.0 mg l^{-1} and 14.2-16.33 mg l^{-1} in Ken and 76-91 mg l^{-1} , 191-222 μScm^{-1} , 104-120 mg l^{-1} , 88.0-100 mg l^{-1} and 16.69-17.75 mg l^{-1} in Betwa. Dissolved organic matter was slightly higher in Betwa (1.10 mg l^{-1}) than Ken (0.87 mg l^{-1}) but both phosphate and nitrate were either in traces or very low in both the rivers.

Rate of energy transformation: The rate of energy transformation was on average 2716 $\text{cal m}^{-2}\text{d}^{-1}$ in Ken and 2203 $\text{cal m}^{-2}\text{d}^{-1}$ in Betwa. The rate was quite low during monsoon and showed considerable increase in post monsoon months.

Biotic communities: Plankton population in Ken ranged from 210 ul^{-1} (Banda) to 310 ul^{-1} (Daudhan). Considerable inter-stretch qualitative variations were observed with dominance of chlorophyceae at Banda, diatoms at Raneh and myxophyceae at Daudhan. The plankton abundance in Betwa ranged between 430 ul^{-1} (Badgaon) and 535 ul^{-1} (Anjanighat). Inter-stretch variations were observed with diatoms dominating at Badgaon and myxophyceae at Anjanighat. Important species encountered in both the rivers were *Cymbella*, *Synedra* and *Navicula* among diatoms, *Eudornia*, *Selenastrum* and *Ankistrodesmus* among green algae and *Merismopedia*, *Oscillatoria*, *Microcystis* and *Aphanizomenon* among blue greens.

Periphytic population was in the range of 1071 ucm^{-2} (Daudhan) to 4670 ucm^{-2} (Banda) in Ken and 680 ucm^{-2} (Anjanighat) to 1310 ucm^{-2} (Paricha) in Betwa. Diatoms were predominant at all the centers and comprised mainly

Cymbella, *Synedra* and *Navicula*. Benthic population was in range of 70 nm⁻² to 110 nm⁻² in Ken and 80 nm⁻² to 360 nm⁻² in Betwa. Mollusc, Annelides and insects were the main benthic organisms in both the rivers.

Piscine diversity: A total of 61 species were recorded during investigation period from Betwa river of which 59 were native species and 2 exotic species (*C. carpio* and *Oreochromis niloticus*). As per genera and species, cyprinidae has maximum diversity among all the families.

Environmental flow studies

The stretch of river Sone below Indrapuri barrage at Dehri-on-Sone up to Koilwar (before confluence with Ganga) was taken for environmental flow studies. The discharge rate from the barrage during seventies was of very high order (14,361,533 cusecs) which has reduced to 1,695,517 cusecs in 2007, a decline by 88.2% within a span of three decades. The reduction in flow rate has completely changed the morphology of the river and even in the peak flood period (Aug) the river was found to be divided in three segments with some water on both sides and more than one km dry sandy bed in the middle. The current velocity was found to be high (2.06-3.3 km h⁻¹) only in flood season but reduced to 0.45-0.7 km h⁻¹ during Dec.

The sediment quality remained completely dominated by sand (92.8%). Water was alkaline in reaction (pH 7.6), rich in oxygen (7.4 mg l⁻¹) with moderate values of alkalinity (74.5 mg l⁻¹), conductance (188.5 µS cm⁻¹), dissolved solids (103.5 mg l⁻¹) and hardness (88 mg l⁻¹).

Dissolved organic matter was quite high (1.74 mg l⁻¹) but nutrient status was poor. The rate of energy transformation by producers was on average 2663 cal m⁻² d⁻¹ and 2757 cal m⁻² d⁻¹ at Dehri and Koilwar, respectively. The average plankton concentration at the two places were 165 ul⁻¹ and 310 ul⁻¹ respectively, while macrobenthos was 128 nm⁻² and 140 nm⁻².

Fish diversity: A total of 26 species were recorded from both the sites during observation period. The average catch from landing centers was 52 kg d⁻¹ at Dehri-on-Sone, 38.2 kg d⁻¹ above the Indrapuri barrage, 30 kg d⁻¹ at Koilwar. Fishery was mainly composed of miscellaneous and others (58-67.5%), catfishes (25-33%) with major carp

contributing only 7-12 %. *A. aor* and *A. seenghala* were the main catfishes. Enquiries from local fisherman revealed that there has been constant decline in the catch over the years especially in respect of major carp. It was also reported that both quantity and quality of spawn has declined sharply with the passage of time. The morphological variation in the river created by sharp reduction in the flow rate have led to situation that there is hardly any spawn collection party in the stretches which used to be the main spawn collection centers. Enquiries from local fisherman revealed that there has been a sharp decline in both quantity and quality of spawn.

ESTUARINE FISHERIES

Ecology and fisheries of east-coast estuarine systems Subarnarekha estuary

Investigation on Subarnarekha estuary was initiated during April, 2008. The tidal impact is felt only up to about 45 km (i.e. Jaleswar) in Orissa. Thus the estuarine portion is only around 9.5% of the total length of the river. A weak salinity gradient (5.35 to 0.05 ppt) developed over an 8 km stretch from near sea mouth onwards, only in the post-monsoon. From January onwards salinity distribution was over a wider stretch (7.0 ppt at sea mouth, 3 ppt at mid-estuary and 0.39 ppt at the head).

Fish diversity and Fisheries : A total of 109 species of fishes, belonging to 44 families and 12 Orders have been collected/documented and identified till January, 2009. Nine species of prawns and 6 species of crabs have so far been recorded from different zones of the estuary. With a dominance of carp fishery, principally constituted of *Labeo calbasu* in the freshwater zone (Jaleswar to Dahamunda), the saline zone of the river supports a good variety of fishes and decapod crustaceans. In the medium saline zone at Ramnagar (Rasulpur) mullets were found to be the most dominant. From Dahamunda to the saline zone *Rhinomugil corsula* constitute a sizeable fishery. The fishing gears operated during different seasons included set-barrier, bag-net, drift gill and drag-nets, cast net, small pieces of thick-meshed dragnets (operated by two persons) and hooks &



lines. An indigenous method of fishing known as “Khadan fishing” has been observed at Jaleswar and Dahamunda. *Tenualosa ilisha* was found to be one of the most dominant species in the catches at the confluence point with Bay of Bengal during monsoon, contributing about 25 % of the total catch of about 10 t /day. *Lotes surinamensis*, *Arius jella*, *Sardinella melanura*, *Coilia dussumeiri* etc., were the other major contributors. Though Hilsa migration takes place upto Jaleswar the catch of hilsa comes down from Dahamunda and is found in stray at Jaleswar.

Godavari estuary

Fish diversity and Fisheries : A total of 110 species of fishes, belonging to 52 families and 15 Orders have been collected and identified up to December, 2008 in Godavari. The fish species include *Tenualosa ilisha*, *Hilsa kelee*, *Anadontostoma chacunda*, *Sardinella melanura*, *Tricanthus brevirostris* *Stolephorus dubiosus* etc. Mullet *Liza parsia*, *Liza tade* and *Mugil cephalus*, Cypriniform fishes e.g., *Labeo calbasu*, *Labeo bata*, *Puntius sophore*, *Puntius ticto*, *Salmostoma* spp., *Rohtee oglibii*, etc. the Goatee croaker *Dendrophysa russeli*, *Pama pama*, *Chanda Chanda nama* and *Ambasys gymnocephalus*, *Lates calcarifer*, *Therapon jarbua*, Pearlsport, *Etroplus suratensis*, *Thryssa malabaricus*, *Glossogobius guiris*; Cat-fishes e.g. *Sperata aor*, *Mystus cavasius*, *Mystus bleekeri*, *Eutropiichthys vacha*, *Pangasius pangasius*, *Tricanthus brevirostris* etc. Eleven prawn and six crab species have also been recorded. The prawn species encountered in both the distributaries (Gautami and Vashist) of the estuary include *Macrobrachium rosenbergii*, *M. malcolmsonii*, *M. scabriculum*, *M. equidens*, *Parapaeneopsis sculptilis*, *Penaeus mondon*, *Fenneropenaeus indicus*, *Meatapenaeus brevicornis*, *Meatapenaeus monoceros* etc. *Scylla serrata*, *Portunus sanguinolentus*, *Portunus pelagicus*, *Veruna* sp. and *Uca* spp. etc. were the crab species recorded.

During pre-monsoon study (May, 2008) maximum landing

of hilsa was observed at Yanam on Gautami and Narsapura (Near Antarvedi) on Vashist branch. The size of the fish ranged between 200 mm/ 80 g and 400mm/ 640g. During monsoon months the hilsa fisheries was found to be extended up to Dwaliswaram where maximum landing of hilsa was observed. *Tenualosa ilisha*, one of the most dominant contributor in the fishery, had a share of more than 30 % of total landing in the both the branches of the estuary as revealed from the samples collected from different gears. During December contribution of hilsa to the total landing was poor. Hilsa fry, 50 to 65 mm size, were encountered slightly above Yanam.

During May, 2008 the mangrove zone of Gautami at Ghutandeevi demonstrated dominance of gastropods (61.11 %) in macro- zoo-benthos whereas polychaetes contributed only 16%. Larvae of *Veruna* sp. was also encountered. At Antarvedi (sea face of Vashist) also gastropods dominated the benthic macro-faunal population contributing more than 61% while polychaetes had a share of 23%. During monsoon macro-zoo-benthos demonstrated an overall dominance of gastropods in both the branches of the estuaries.

During pre-monsoon period (upto June, 2008) the salinity, particularly in the lower most part of both the branches, increased considerably at Ghutandeevi (the mangrove zone of Gautami) from 19.16‰ (January) to 32.52 ‰ while at Antarvedi the salinity increased from 24.40‰ (January) to 31.62‰. The Babbarlanka sampling site (before bifurcation of the river) was found to be completely dried up and so also Siddhantham. The salinity considerably decreased during monsoon months and at Antervedi and Ghutunadeevi the salinity during Sept. was observed to be very low being 1.69 and 0.12 ‰ respectively. The salinity in both the branches again demonstrated an increasing trend during December, 2008 when at Antervedi the salinity was to the tune of 33.42 ‰ while at Ghutunadeevi it was 18.62‰.

'Khadan' fishing in
Subarnarekha estuary



Table 1: Trend of fisheries in Godavari Estuary

FISH	Yield (t)		
	1980s	2006-07	2007-08
Gautami Branch			
Shark & Skates	218.00	30.00	31.00
Hilsa	231.00	7.00	8.00
Other Clupeids	210.00	51.00	53.00
Catfish	260.00	3.00	4.00
Mulletts	223.00	2.50	3.00
Polynemids (Perches)	13.00	114.00	111.00
Caranx & other Carangids	130.00	11.00	8.00
Ribbon fish	131.00	11.00	39.00
Mackerals & other Scombridge	103.00	39.00	22.00
Pomfrets	103.00	29.00	5.00
Prawns	311.00	133.00	135.00
Crabs	110.00	22.00	25.00
Others	640.00	484.50	462.00
Sub-Total	2795.00	910.00	907
Vashistha Branch			
<i>Mostly perches prawns and crabs</i>	1205.00	182.00	193.00
GRAND TOTAL	4000.00	1092.00	1100.00



Migratory pattern, behaviour and other relevant data for designing fish passes for hilsa and other species for their migration

Hilsa migration pattern in Hooghly

Major upstream migration of hilsa was observed from August to November, beginning with the start of monsoon and consequent flooding. A milder second phase of migration of mature hilsa, but relatively smaller in size, was also observed during Feb-Mar. Peak migration of adult fish was found occurring shortly before the spawning. Lunar cycle has a definite influence on hilsa migration, as migration activity was observed to be vigorous four to five days before and after the full moon and new moon. The favourable conditions for hilsa migration were:

- >4 m depth
- >20 m/minute current velocity
- Reasonably adequate freshwater discharge from upstream stretches
- Low salinity, high turbidity, high siltation at the estuarine mouth have adverse impact on hilsa migration.

During migration about 90% of the migratory stock was observed to be in mature condition indicating breeding as the main reason for migration. The undersized hilsa (*Hilsa ilisha*) below 500 g were being caught in plenty using monofilament of 80-85 mm or below mesh size fishing nets at Frasergunj defeating the very purpose of stock sustenance and dwindling hilsa fishery in the Hooghly estuary. The situation has been even graver with the application of shore seine, killing hilsa brooders brutally prior to their breeding migration to the estuary at the inshore water, near the estuarine mouth at Frasergunj during July. The fish catch recorded from five trawlers at the Frasergunj Fishing Harbour was to the tune of 5.670 t in which the contribution of hilsa alone was 3.195 t (56.3%). Rest 2.475 t (43.7%) included mackerels, sardines, pomprets and others besides a significant share of *Harpodon neherius*. The length-weight data of 261 specimens revealed that the species ranged from 225 to 440 mm in length and 140 to 1240 g in weight of which 96% were female. Males (225-

370 mm; 140-780 g) were smaller in number as compared to the females (255-440 mm; 150-1240 g). With regards to the maturity condition, 59.8% of the fishes were in 4th stage of maturity followed by 26.3% in 3rd stage, 7.5% in 2nd stage and 6.4% in 5th stage. More than 50% of the fish measured during this period were below 500 g varying between 100 and 490 g. The fishing ban in the inshore waters along the West Bengal Coast is being imposed from April 15th to June 30th every year. The present investigation, therefore, indicate that the breeding migration of hilsa takes place in July, which may prolong till August and as such the prevailing period of closed season need to be extended preferably up to middle of August to protect the precious hilsa brooders in general and hilsa fishery in particular, especially in the estuarine stretch. It has also been observed that bottom trawling is being practiced within the territorial water areas catching the hilsa brooders, damaging the feeding grounds of hilsa in a big way. Despite the ban on the usage of gill nets below 90 mm mesh size and shore seine below 25 mm mesh size, lower meshed nets are being used abundantly, affecting the hilsa fishery adversely. Strict compliance of the mesh regulation for commercial exploitation would therefore be essential to protect the hilsa fishery in Hooghly estuary. Besides this, strict ban on the catch of hilsa juveniles needs to be imposed.

Ecology, bio-diversity and fisheries of a brackish-water lagoon – Pulicat

Pulicat Lake extends between Ponueri and Gumidi- pundi taluk of Thiruvallur district in Tamil Nadu and Sullurpet and Tada Taluk of Nellore district in Andhra Pradesh, covering an area of about 461 km². Presently, the lake has an effective water area of 350 km² only. The lake extends to about 59 km, north to south, with a maximum width of 17 km towards the northern sector. The lake opens into the Bay of Bengal through a narrow passage at its southern end, near the Pulicat town and at Sriharikota in the northern side. It is a shallow lake with an average water depth of 0.7 m. Three larger inflows besides a number of minor inflows debouch the lagoon.

Biotic production

Phytoplankton : The phytoplankton density indicated greater abundance of dinophyceae (Post-monsoon) and diatoms (winter). The members of chlorophyceae & cyanophyceae, however, were recorded persistently. The density of phytoplankton recorded varying between 325 and 1050 ul^{-1} , being the maximum during post-monsoon.

Zooplankton : Cyclops were the most dominant community followed by protozoa and cladocera in TN part while rotifers and protozoa dominant in AP region. The density of zooplankton fluctuated from 125 to 200 ul^{-1} (Post-monsoon) and 120 to 168 ul^{-1} (winter).

Benthos : The benthic invertebrates of Pulicat lake fluctuated in the range of 1121 nos to 3508 nos.m^{-2} dominated, largely, by gastropods (53.5-63.8%), followed by bivalves (37.6-41.2%) and others like chironomids and tubificids (8.9-10.3%).

Biodiversity : A total of 29 species of fish including one exotic (maximum recorded is 35 spp. in 1980s), 180 species of phytoplankton (Maximum report-43 species), 18 species of zooplankton (maximum report-88 species), 22 species of macro-benthic invertebrates and 30 species of macrophytes (6 species recorded earlier) have been identified, photographed and documented.

Fisheries : The fisheries of Pulicat depend largely on the catch of *P. indicus* (>50 % to the total catch), mullets (*M. cephalus* > *M. tade* > *M. cannei* > *M. macrolaepis* > *Liza Persia*)- around 20% to the total catch. The dominant fishery of 1970s & 1980s, the *Chanos chanos* is rare now (< 2% to the total catch). The abundance of *P. monodon*, the tiger prawn, which was predominant during 1970s & 1980s has also been declined significantly to the tune of more than 95%. Other prawns, contributing to the fishery are

Metapeneaeus dobsonii, *M. monoceros* and *M. brevicornis* (6-8% to the total catch). Green Crab (*Scylla serrata*), which was major fishery in 1980s, has declined alarmingly (> 90%) due to over fishing and wanton killing of matured brooders. On an average, each fisher used to catch 30 crabs in 1980s, which has now declined to an average of nearly 02 crabs per fisher per day. *Plotosus canius*, *Sardinella* sp. and *Hilsa keele*, which were sizeable (15-17% to the total catch) contributors during 1980s could not be recorded during the present campaigns. *O. mossambicus*, an exotic fish species, has established in the AP part with good fishery (>17 %). The use of destructive nets & gear have been rampant leading to over-fishing, as evidenced from the sizeable catch of small sized mullets and crabs. The average catch per fisher per day has been estimated to be poor, 200 g to 300g /day, mainly of *P. indicus*.

West-coast estuarine ecosystems

Six sites, viz. Anandpura, Vataman, Ingoli and Rasikpura, representing the lower estuarine expanse and Paladi and Indira Bridge representing the upper extent of Sabarmati estuarine were identified based on salinity gradient. Seasonal sampling was resorted to and only four sites were accessible during monsoon due to floods. The salient findings relevant to monsoon and winter campaigns are as follows:

Water Quality: The water reaction was alkaline, pH 7.1-7.8. The dissolved oxygen levels (nil to 8.6 mg l^{-1}) indicated Sabarmati estuarine system being a stressed environment, particularly the expanse from Rasikpura to Anandpura where critically low content of D.O (nil to 3.2 mg l^{-1}) was recorded. This highly stressed condition may be attributed to the discharge of composite effluents into the system, having high oxygen demand. There is hardly any flow in the expanse from Ingoli to Paladi which resembled a static mass of water having brown to blackish colour. However, improved environmental conditions were recorded at upper stretch denoted by Indira Bridge.

Table 2: Trend of fishery in Pulicat lake

States	1980s	2007-08	2008-09
Andhra Pradesh	6500 t	2345 t	1747 t
Tamil Nadu	2835 t	220 t	2145 t
Total	9335 t	4545 t	3892 t



***P. indicus*, the major fishery in Pulicat**

The Sabarmati estuarine system was rich in phosphorus (0.036 to 0.344 mg l^{-1}). Based on the nitrate levels (0.426 to 0.723 mg l^{-1}), Sabarmati estuarine system may be categorized as productive system while silicate (12.232 to 13.312 mg l^{-1}) was abundantly available and thus corroborated the above inference. *Sediment's Quality:* Sediment reaction was alkaline and the pH varied from 8.27 to 8.52 for the Sabarmati estuarine system as a whole. Organic carbon content (0.253 to 0.880%) denoted fairly rich status of the system which was corroborated by available phosphorus (1.09 to $2.76 \text{ mg } 100\text{g}^{-1}$) levels. Available nitrogen content of the system as a whole fluctuated between 9.92 to $16.77 \text{ mg } 100\text{g}^{-1}$ which reflected fairly rich status of the system.

Soil texture was predominantly sandy (68.0 to 94.0%).

Spatio-temporal Variations of Plankton: The average plankton abundance in the estuarine system widely varied along the stretch: 76 nos. l^{-1} at Anandpura, 333 nos. l^{-1} at Vataman, 160 nos. l^{-1} at Ingoli, 1072 nos. l^{-1} at Rasikpura, 5048 nos. l^{-1} at Paladi and 1022 nos. l^{-1} at Indira Bridge. Phytoplankton varied from 77.17 to 96.08% . The zooplankton assemblage (3.92 to 41.16%) was mainly comprised of Rotifera and Protozoa.

Spatio-temporal Variations of Macro-benthos: Like plankton, the macro-benthic abundance of Sabarmati estuarine system drifted widely between 9 (Anandpura) to 1672 nos. m^{-2} (Paladi). Diptera mostly represented by chironomid larval forms and other developmental stages excelled as the most prevalent macro-faunal element while Molluscan population was mainly represented by *Thiara tuberculata*, *T. scabra*, *T. lineate*, *Bellamaya bengalensis*, *Segmentina* sp. and *Segmentina* sp.

Fish and Fisheries: Fishing activities were prevalent all along the whole stretch during monsoon season whereas fishing is confined to Paladi and Indira bridge expanse during post-monsoon and winter. The gears used are Cast and Gill net. The fish species encountered were *Labeo bata*, *Mystus seenghala*, *Chela bacaila*, *Labeo rohita*, *Catla catla*,

Cirrhinus mrigala, *Notopterus notopterus*, *Belone cancala*, *Osteobrama cotio*

RESERVOIR FISHERIES

Improving fish yields in small reservoirs in different agro-climatic zones

Suvarnavathi Reservoir (Karnataka)

This small reservoir was selected for conducting trials after consultation with Karnataka Cooperative Fisheries Federation, Mysore, who are developing the reservoir under NFDB funds.

Physico-chemical features of water: The water temperature in the surface layers varied from 25°C in December to 31°C in May. Transparency was low, 0.95 m in September due to inorganic turbidity to 1.7 m in October. pH was alkaline, between 7.2 and 8.3 . Ionic concentration was highest in July coinciding with low water level and lowest in January and was in the medium range (100 to $253.0 \text{ }\mu\text{S/cm}$). Reservoir exhibited strong thermal stratification during April and November with the thermocline between 2 and 6 m and oxygen exhibiting strong clinograde distribution. The reservoir was in complete circulation in December due to convective cooling and inflow.

Primary production: The GPP was highest in November ($5923.2 \text{ mgC/m}^2/\text{d}$) and lowest in October ($1199.2 \text{ mgC/m}^2/\text{d}$). The mean GPP was $2006.6 \text{ mgC/m}^2/\text{d}$. The net primary production (NPP) had a high of $1799.2 \text{ mgC/m}^2/\text{d}$ in April and a low of $374.9 \text{ mgC/m}^2/\text{d}$ in July (Mean of $848.6 \text{ mgC/m}^2/\text{d}$) in October. Highest community respiration was recorded in November ($2961.6 \text{ mgC/m}^2/\text{d}$) and the lowest in February ($434.4 \text{ mgC/m}^2/\text{d}$) with a mean of $956.7 \text{ mgC/m}^2/\text{d}$.

Plankton: The phytoplankton density (April to September) varied from 190 units/l to $48,675 \text{ units/l}$ (Mean 19188 ± 22969). Chlorophyceae was dominant followed by Myxophyceae. *Pediastrum*, *Microcystis* and *Ceratium* were common and abundant. The zooplankton density (April to September) varied from 194 No./l to 485 No./l (Mean 360 ± 125). Rotifers were dominant forming 8.2 to 64.9% of the zooplankton community followed by copepod nauplii (16.9 to 48.3%). Rotifers were species-rich suggesting productivity of the water. *T. hyalinus*, *H. viduus*, *D. excisum*, *Keratella*, *Brachionus* spp. were common forms. Based on the limnological parameters, the reservoir is productive.

Fishery: The reservoir is under lease to a society. All the fish

catch is brought to one point near the right bank of the dam. The average fish seed stocking rate for the years 2006 to 2009 was a high of 875 No./ha/year with catla constituting 41.6%, rohu 19.1%, mrigal 11.3%, common carp 23.7% and grass carp 4.3%. The stocking size of 3 to 5 cm is far from satisfactory.

The number of fishing days was a low of 204 days during February 2008 to January 2009. For more than five months in a year, fishing is not conducted, which is not remunerative to the fishers. A total catch of 45.1 t was recorded with the highest landings of 6.1 t recorded in September and lowest of 2.0 t in November. *Indian major carps contributed a high of 93.8% to the total catches with the rest mainly by tilapia.* All the three species of IMC exhibit good growth. The CPUE maxima of 19.8 kg was observed in December and the minima of 7.6 kg in November (Fig. 1). The mean CPUE was a high of 11.5 kg. The fish yield for the period February 2008 to January 2009 was 123.4 kg/ha as compared to 101.3 kg for the same period of last year.

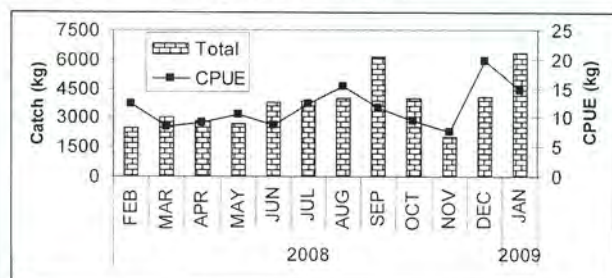


Fig.1. Monthly variation in fish catch and CPUE from Suvarnavathy reservoir

Major carps do not exhibit natural recruitment and the fishery is sustained mainly by stocking. Contribution of minor catfish like *O. bimaculatus* and *M. cavasius* and tilapia is negligible in contrast to what is observed in many Cauvery river basin reservoirs of Karnataka.

Kanjirapuzha reservoir (Kerala)

Soil and water quality: The pH of the soil was acidic (4.46 to 5.07) in nature and the conductivity ranged from 75.4 to 173.7 μScm^{-1} . Organic carbon of the soil varied from 0.3 to 2.85 %. The pH of the water was around neutral (7.02-7.58) through out the year. Dissolved oxygen at surface ranged from 6.8 to 10.4 mg l^{-1} . There was no oxycline at any season observed. But the lower content of dissolved oxygen or anoxic condition was observed only at station 2 during May,

September and November 2008. The station 2 is a protected area where there may be restricted water movement. Carbon dioxide was observed in water at all depths in all the months except April and May. Total alkalinity ranged from 19.2 to 32.0 mg l^{-1} whereas the hardness ranged from 9.0 to 21.6 mg l^{-1} . Nitrate nitrogen ranged from 0.10 to 0.29 mg l^{-1} whereas Phosphate P content in water was very low ranging from 0.01 to 0.06 mg l^{-1} . The gross primary production estimated from this reservoir was low which ranged from 11.70 to 46.37 $\text{mg C/m}^2/\text{yr}$.

Plankton: Plankton comprised more than 97.75 % of phytoplankton which chiefly composed of desmids. The zooplankton composed mainly of rotifers followed by copepods and protozoans. Among the benthic population, which ranged from 109 to 1856 Nos/ m^2 *Chironomous* sp was the single dominant species present in sediments of Kanhiraphuza reservoir. Polychaetes were seldom observed in station 1.

Fisheries : The rate of stocking and the species composition was decided as per the CIFRI guidelines for small reservoirs. Accordingly, it was proposed to stock the reservoir with 154500 fingerlings (@300 Nos./ha) and the species composition was catla (40%) = 61800 nos., mrigal (30%) = 46350, rohu (15%) = 23175 Nos. and common carp (15%) = 21375 Nos. A total of 68401 nos. of fingerlings of 8-10cm size consisting of 4006 catla and 64395 mrigal were stocked by CIFRI.

Fish catch: The fish catch was mainly comprised of *Gonoproktopterus curmuca* (Av. 255.9 mm; 208 g), *Amblypharngodon mola* (Av. 83 mm; 5.8 g), and *Puntius filamentosus* (Av. 147 mm; 49.9 g). *Ompok bimaculatus* and *Wallago* sp. are rarely found in the catch. Only from January 2009 fishing was operated and per month the total catch was around 600 kg which is mainly dominated by *G. curmuca*. Experimental fishing was carried out using 40mm size monofilament net. *G. curmuca* (Av. length 272 mm; wt: 220 g) and *Puntius filamentosus* (Av. 142 mm; 46.6 g) were observed in the catch. Very few numbers of stocked fingerlings mainly mrigal was observed in the catches (av. Length & wt: 180 mm; 145 g).



Arjun Sagar reservoir (Uttar Pradesh)

Arjun Sagar reservoir constructed during 1st five year Plan with a total area of 1890 ha with 1090 ha F.S.L. and 700 D.S.L. situated in hot dry belt in Bundelkhand region of Uttar Pradesh was undertaken for enhancement of fish production work. Examination of data on fish production from the reservoir reveals that the average fish production from the reservoir during the years 1992-2001 was of high order (average 51.4 kg/ha/year) which declined during the years 2001-2008 to an average of 18.3 kg/ha/year. This decrease in fish production is mainly attributed to severe reduction in the water volume of the reservoir and inadequate stocking. The water quality parameters with rich oxygen 7.84 to 9.12 mg/l, alkaline pH (7.8-8.0), 90-106 mg/l alkalinity, 151-238 µmhos/cm conductance, 56-106 mg/l hardness and dissolved organic matter 0.9-2.25 mg/l all indicated good productive character of the reservoir, although nutrient status was observed to be poor. Among biotic parameters the average plankton population of the reservoir was 418 ul⁻¹ mainly dominated by bacillariophyceae among phytoplankton and rotifers and crustaceans among zooplankton. The macro-benthic population was on average 216 um⁻² dominated by molluscs.

The rate of net carbon production studied by C-14 carbon technique was on average 441.2 mgCm²day⁻¹. Based on photosynthetic rate the fish production potential of the reservoir was estimated as about 150 kg ha⁻¹ year⁻¹. Keeping in view a growth rate of about 500 gm of individual fish species with an initial weight of 25 gm at the time of stocking and with an assumption of 10% mortality rate the stocking density of 330 nos. fingerlings per ha was estimated.

Prior stocking of the reservoir repeated netting operations were undertaken to remove predatory fishes as far as possible. The species encountered were *Ophicephalus* sp., *Notopterus* sp., *Wallago attu*, *Aorichthys* sp. along with trash fishes. About five lakh nursery reared advance fingerling of IMC, about av. length 110 to 120mm both from riverine seed (River Yamuna) and from hatchery in the ratio of 20% *Catla catla*, 40% *Labeo rohita* and 40% *C. mrigala* has been stocked in the reservoir during August/September months after proper acclimatization.

During late September and October, the reservoir was further stocked with grass carp (1.5 lakh) and common carp (about 1 lakh) advance fingerling. Though regular fishing in the reservoir is to be initiated, during experimental fishing *L. rohita* and *C. mrigala* specimens were observed to have attained an average weight of 300 gm. Fishing by gill-nets (Fasla) during February and March for 41 days yielded 6800 kg of fishes.

Characterization of fishery and population trends

Kelavarapalli Reservoir (Tamil Nadu)

A static mass balance model of the Kelavarappalli reservoir was constructed using Ecopath software and the balanced model was then used to analyze the food web ecology and ecosystem properties of the reservoir. The Biomass, Production/Biomass, Consumption/Biomass (Table 3) were estimated for the ecological groups and used as input parameters for balancing the model.

Table. 3 Input parameters for the Ecopath model of Kelavarapalli Reservoir

Ecological groups	Biomass (t/km ²)	P/B	Q/B
Fish eating birds	0.560	0.33	0.840
African catfish	0.069	2.14	10.800
Other catfishes	0.140	2.900	4.750
Snake heads	0.050	2.670	7.600
Mossambique Tilapia	0.933	2.800	6.200
Nile Tilapia	10.990	3.600	31.300
Other Cichlids	0.130	2.800	12.890
Major carps	3.143	9.400	16.500
Dipterans	6.000	18.000	38.750
Zoobenthos	10.100	4.210	21.050
Zooplankton	33.000	45.800	99.800
Macrophytes	63.600	97.350	-
Phytoplankton	32.000	188.600	-
Detritus	24.000		-

The Mixed Trophic Impact (MTI) routine was used to evaluate critical trophic interactions between groups in the ecosystems and also to assess the impact of the exotic fishes on other indigenous fishes. The system omnivory index therefore characterizes the diversity of consumer – prey relationships. Niche overlap is used to describe mainly the trophic aspect of niche partitioning. The gross efficiency of the fishery (GEF) is computed as the ratio between the total catch and the total primary production in the system. The mean trophic level (TL) of the catch was calculated as the mean of TLs of groups included weighted by the contribution to total catch.

Table.4 Parameters calculated for the Kelavarapalli ecosystem model

Ecological groups	TL	EE	P/Q	FtD	NE	OI
Fish eating birds	3.57	0.000	0.393	0.279	0.491	0.142
African catfish	3.42	0.000	0.198	0.267	0.248	0.058
Other catfishes	2.72	0.903	0.611	0.157	0.763	0.422
Snake heads	3.01	0.531	0.351	0.138	0.439	0.347
Mossambique Tilapia	2.59	0.042	0.452	3.656	0.565	0.402
Nile Tilapia	2.21	0.010	0.119	105.739	0.149	0.166
Other Cichlids	2.17	0.543	0.217	0.492	0.272	0.144
Major carps	2.15	0.005	0.570	39.916	0.712	0.125
Dipterans	2.35	0.021	0.465	152.171	0.581	0.228
Zoobenthos	2.29	0.003	0.200	84.789	0.250	0.205
Zooplankton	2.00	0.146	0.459	1948.852	0.574	0.000
Macrophytes	1.00	0.160	-	5200.139	-	0.000
Phytoplankton	1.00	0.276	-	4367.277	-	0.000
Detritus	1.00	0.111	-	0.000	-	0.175

TL is the trophic level, EE is the ecotrophic efficiency, P/Q is the production/consumption ratio, FtD is the flow to detritus ($\text{t km}^{-2} \text{yr}^{-1}$), NE is the net efficiency and OI is the omnivory index

Several flow indices: (a) the total system ascendancy, (b) the total system throughput, (c) the Finn's cycling index (d) the path length were computed. A number of statistics describing an ecosystem as a whole were used to assess the status of the ecosystem in terms of maturity. Summary statistics are totals of consumption, exports, respiration, and flows to detritus, primary production.

Table.5 Summary Statistics of Kelavarapalli reservoir

Parameter	Value	Units
Sum of all consumption	4133.080	$\text{t km}^{-2} \text{year}^{-1}$
Sum of all exports	10655.070	$\text{t km}^{-2} \text{year}^{-1}$
Sum of all respiratory flows	1571.600	$\text{t km}^{-2} \text{year}^{-1}$
Sum of all flows into detritus	11903.870	$\text{t km}^{-2} \text{year}^{-1}$
Total System Throughput (TST)	28264.000	$\text{t km}^{-2} \text{year}^{-1}$
Sum of all production	13961.000	$\text{t km}^{-2} \text{year}^{-1}$
Calculated total net primary production	12226.660	$\text{t km}^{-2} \text{year}^{-1}$
Total primary production/Total respiration	7.780	
Net system production	10655.070	$\text{t km}^{-2} \text{year}^{-1}$
Total primary production/total respiration	76.070	
Total biomass/total throughput	0.006	
Total biomass (excluding detritus)	160.715	t km^{-2}
Connectance index	0.296	
System Omnivory Index	0.156	
Ascendancy	35.92	
Finn's mean path length	2.312	
Finn's cycling index	3.04	% of TST

System statistics

P/R ratio of Kelavarapalli reservoir is 7.780, which is much larger than 1, leading to a conclusion that this reservoir is relatively at developmental stage or a young ecosystem. The high net system production ($10,655.07 \text{ t km}^{-2} \text{y}^{-1}$) in this reservoir shows this is an immature system. The TPP/TB value for is very high (76.07) indicating the immaturity of this system. Total biomass/total throughput can be expected to increase to a maximum for the most mature stages of a system. This value (0.006) also shows that this system is in developmental phase (Table 5) and hence ideal for applying enhancement methods for higher fish production.

Exploratory survey of reservoirs

An exploratory survey was undertaken on various reservoirs along Kerala, Tamil Nadu and Karnataka to assess the present status of their ecology and fisheries. The reservoirs investigated were Kuttiadi reservoir, Banasura



sagar dam, Karappuzha dam, Mettur reservoir Bhavanisagar, Thoppur dam, Amaravathy reservoir, Jampadahalla reservoir, Bhadra reservoir, Linganamakki tunga reservoir.

Karapuzha Reservoir

After conducting exploratory survey of reservoirs in three states, this project is reoriented and focus is shifted from a high yielding reservoir Kelavarpalli (180 Kg/ha) to a low yielding reservoir (20 Kg/ha) with thinner population at Karapuzha, Waynad district, Kerala. Here fishing activity is comparatively less. The CPUE and catch are meager but species spectrum is wider. This reservoir seems to be ideal for application of various types of enhancements using CIFRI technology.

Water quality: Water quality parameters showed that the water temperature fluctuated from 25.3 (in July) to 28.8 °C (in February'09). Surface pH ranged from 7.6 to 8.2. Dissolved oxygen (DO, mg/l) content of the water varied from 6.12 in July to 7.45 in February. Specific conductance (μScmr) values ranged from 97.0 (November) to 135.0 (February'09). Nitrate values (μScmr) ranged from 9.08 to 16.23. Phosphate value (μScmr) was lowest in October and highest in the month of September (27.0). Silicate values (μScmr) did not show much fluctuation, varied from 14.6 in November to 16.4 in October. Low primary productivity values were recorded with GPP of $62.5 \text{ mg C m}^{-3} \text{ h}^{-1}$ and NPP of $46.88 \text{ mg C m}^{-3} \text{ h}^{-1}$.

Plankton: Plankton analysis showed the dominance of phytoplankton over zooplankton during all months except in November when zooplankton dominated (61.4%).

Fish and Fisheries: During July 2008 to February 2009, 12.5 tonnes of fishes were landed at Karappuzha Reservoir with a CPUE of 6.1 Kg. The maximum catch was recorded in January 2009 whereas the highest CPUE was recorded in the month of December 2008. The fish catch and CPUE at this reservoir showed decline after July but the decline is not substantial as the number of units operated had reduced probably due to some regulation by irrigation authorities on fishing and a temporary ban to operate crafts in this reservoir as there were coracle accident deaths happened during September. The CPUE showed steady increase due to the lesser number of coracles operated fetching higher catch per unit by those fishermen who defied the fishing ban.

Oreochromis mossambicus dominated the catch at Karapuzha reservoir forming 67.2 % of the total fish catch followed by *Clarias gariepinus* (10.7%), *Labeo rohita* (8.0 %), *Catla catla* (7.8 %), *Heteropneustis fossilis* (1.9 %), *Mystus cavasius* (1.7 %), and *P. waynadenensis* (1.7 %). The sizes of *O. mossambicus* ranged from 13 to 28.5 cms with maximum modes at 15 cms (October), 18.5 cms (November) and 19.0 cms in December. The mean length was 17.8 cm (October) and 18.4 cm (November and December). (Fig. 2).

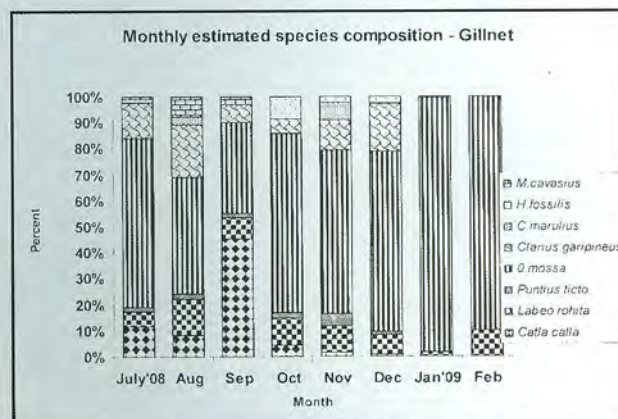


Fig. 2 Monthly estimated species composition (Gill Net)

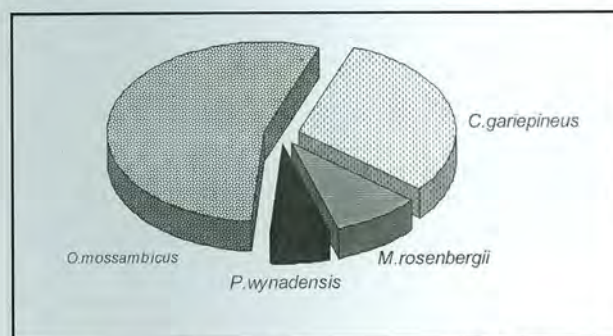


Fig.3 Experimental fishing - Species composition at Marachankolli - Karapuzha (Lotic zone)

Experimental fishing at Karapuzha Reservoir: Experimental gillnet fishing was conducted at different sites at Karapuzha Reservoir in from November 2008 to February 2009. The gear for the experimental gillnet fishing was made of nylon monofilaments with knot-to-knot mesh sizes of 50, 60, 70, 90, and 110mm. These nets had 3 to 4.0 m hanging depth. Sets of these gillnets of all the mentioned mesh sizes were assembled, in order of mesh size, to panels

of 350 metres total length (50 & 60 mm mesh size - 2 panels - bottom), 475 metres length for (70mm mesh size x 3 panels - column) and 200 metres (90 & 110 mm mesh size x 1 panel - surface). A separate 30 mm mesh size of 50 metres length was set at the bottom of reservoir. One habitat was sampled at a time, and all panels were placed in that habitat. The panels were placed from around 1600 hours and were soaked till next day morning. (Fig. 3-5).

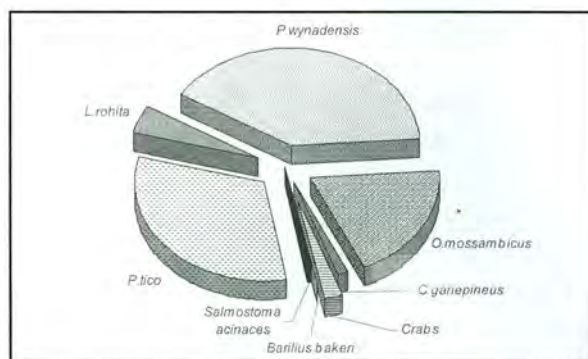


Fig.4 Experimental fishing - species composition at Poolakkavala - Karapuzha reservoir (Littoral zone)

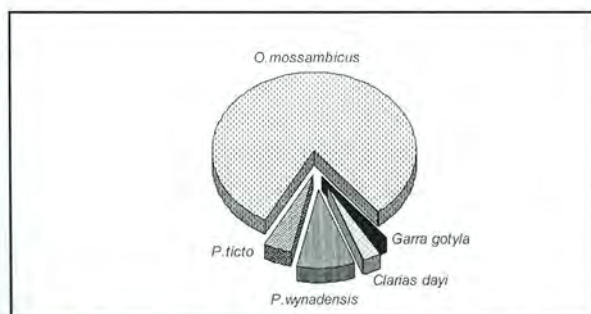


Fig.5 Experimental fishing- species composition at Karapuzha reservoir - lentic zone

The experimental fishing was conducted twice in each zone viz. Lotic, lentic and Intermediate zones of the reservoir. The gill nets were positioned in surface, column and bottom of the reservoir in each experiment.

The gill nets positioned on the surface yielded 53.5 % *Oreochromis mossambicus* followed by *L. rohita* (39.8 %) and highly priced *Macrobrachium rosenbergii* (6.7 %) whereas the column gill net catch showed 91 % tilapia

followed by *Macrobrachium rosenbergii* (5%) and crabs (4%). The bottom gill nets yielded diverse catch consisting of fourteen different species. The dominance of tilapia reduced to 33 %. The rest of the catch consisted of *Puntius wynadensis* (20 %), *P. ticto* (19 %), *P. terio* (5%), *H. fossilis* (5%), *Barilius bakeri* (4%), *Garra gotyla* (3%), *Mystus armatus* (2%) and *Salmostoma acinaces* (2%).

The catch at lotic zone in experimental gill nets fetched tilapia (55%), *C. gariepinus* (30 %) *M. rosenbergii* (9%) and *P. waynadensis* (6%) whereas in the intermediate zone *P. waynadensis* dominated the catch forming 32 % of the total catch followed by tilapia (19%), *L. rohita* (5%). *Salmostoma acinaces*, *Barilius bakeri* and *C. gariepinus* also contributed among the miscellaneous groups. In the lentic zone the catch composition was 81 % tilapia followed by *P. waynadensis* (9%), and *Clarius dayii* (5%). *P. ticto* and *Garra gotyla* also found among the miscellaneous catch.

The CPUE varied between 0.70 kg/hr to 2.3 kg/hr in different experiments.

Stocking Details : During November 2006 about 43000- *M. rosenbergii* seeds and 165000 - Catla, Rohu and Common carp seeds were brought from Malampuzha and stocked in Karapuzha reservoir by Kerala State Fisheries Department

Development of models for fish yield estimation in reservoirs

Models were developed for reservoirs after categorizing them into low and high yielding reservoirs. Since the size of the reservoir and yield are negatively correlated ($r = -0.41$), general categorization of reservoirs based on the productivity (viz. low and high) - without taking into consideration their size - would be erroneous replete with subjectivity. Hence, reservoirs were categorized into small (< 1000 ha) and large (> 1000 ha) (based on size) and (again within each category) into low-productive and high-productive. This resulted in a broad classification of reservoirs as (i) small reservoirs with low yield (<100 kg/ha/yr), (ii) small reservoirs with high yield (>100 kg/ha/yr), (iii) large reservoirs with low yield (<50 kg/ha/yr)



and (iv) large reservoirs with high yield (>50 kg/ha/yr). Reservoir data (secondary data) collected from the states of Karnataka, Tamil Nadu, Rajasthan, Andhra Pradesh and Madhya Pradesh was, then, used to estimate the relationship of yield with mean-depth and area of the reservoir. The estimated relations are given in Table 6

Table 6 Estimated relation of Yield with Mean Depth and Area of Reservoirs

Reservoirs Category	Yielding Category	Variables	Relation Type	No. of Case(n)	R ² -Value
Small(<1000ha)	Low (<100kg/ha/yr)	Mean depth vs. Yield	3rd degree Polynomial	10	0.542
Small(<1000ha)	Low(<100kg/ha/yr)	Area vs. Yield	4th degree polynomial	10	0.841
Small(<1000ha)	High(>100kg/ha/yr)	Mean Depth vs. Yield	4th degree Polynomial	10	0.649
Small(<1000ha)	High(>100kg/ha/yr)	Area vs. Yield	Linear logarithmic	9	0.661
Large(>1000ha)	Low (<50kg/ha/yr)	Mean depth vs. Yield	4th degree polynomial	13	0.720
Large(>1000ha)	Low (<50kg/ha/yr)	Area vs. Yield	Linear logarithmic	14	0.327
Large(>1000ha)	High (<50kg/ha/yr)	Mean depth vs. Yield	4th degree polynomial	6	0.481
Large(>1000ha)	High (<50kg/ha/yr)	Area vs. Yield	3rd degree polynomial	8	0.412

Statistical analysis of pooled-data (from all the states) was done to get the estimated relation of catch with mean-depth and area (ie. *mean-depth vs catch* and *area vs catch*). The estimated relationships are shown in Table 7.

Table7 Estimated relation of catch with Mean Depth and Area of reservoirs

Variables	Relation Type	R2 - Value
Mean depth vs. Catch	6th degree polynomial	0.4475
Area vs. Catch	6th degree polynomial	0.7153

N=no. of case=20

WETLAND FISHERIES

Fish stock assessment for sustainable fishery management in wetlands

Eight wetlands of different categories spread across three districts in West Bengal have been studied. The wetlands studied are Chandania (49.5ha), Beledanga (60ha), Chamordaha (38ha), Borthy (1408ha) and Raja (33), situated at 24 Parganas North district; Khalsi (62ha) and Bhomra (45ha) at Nadia district and Kol (69ha) at Hooghly district.

Fish catch : The total fish catch from the wetlands (January to December 2008) ranged from 8.6 to 152t / year with corresponding yield of 0.1 to 1.8t/ha/year. The total fish catch (natural stocks and stocked fishes) from each of the wetlands studied are shown in Fig. 6. Total catch was highest from Borthy (152kg) while the maximum total yield was from Khalsi wetland (1.8kg/ha/year). The contribution of natural fish stocks and that of the stocked fishes are shown in Fig 7. Catch of natural stocks ranged from 5 to 152t/year with a corresponding yield of 0.1 to 0.4t/ha/year, while that of the stocked fishes ranged from 22-49t/year with yield range of 0.4 to 1.6t/ha/year indicating significant contribution of natural fish stocks to total catch from the wetlands. The number of species exploited from the wetlands ranged from 5 to 28. *Puntius* spp. were the major contributors to the catch (20%), followed by *Channa* spp. (18%) and prawns (12%). Among *Puntius* spp., *P. conchoni*, *P. sophore* and *P. ticto* were the major contributors.

The fishing effort for natural fish stocks ranged from 2940 to 19635 fishers/year across the systems. The CPUE for natural fish stocks was 0.9 to 9.4kg/fisher/day with higher CPUE in wetlands having direct riverine connection.

Exploitation pattern of highly priced fishes viz. *Amphipharodon mola*, *Colisa fasciata* and *Puntius sophore*, as indicative samples, having sizeable contribution to catch and common to all these wetlands, showed that their exploitation rates are closer to or higher than the sustainable levels in majority of the cases. About 41-95% of these species caught are immature in most of these wetlands.

Fig.6 Total fish catch and annual yield from the wetlands during January to December 2008.

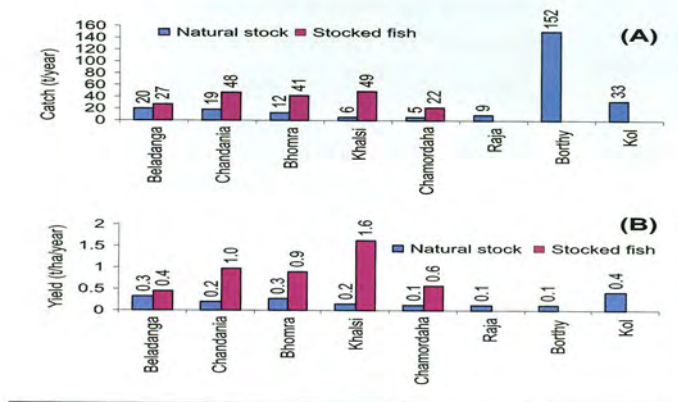
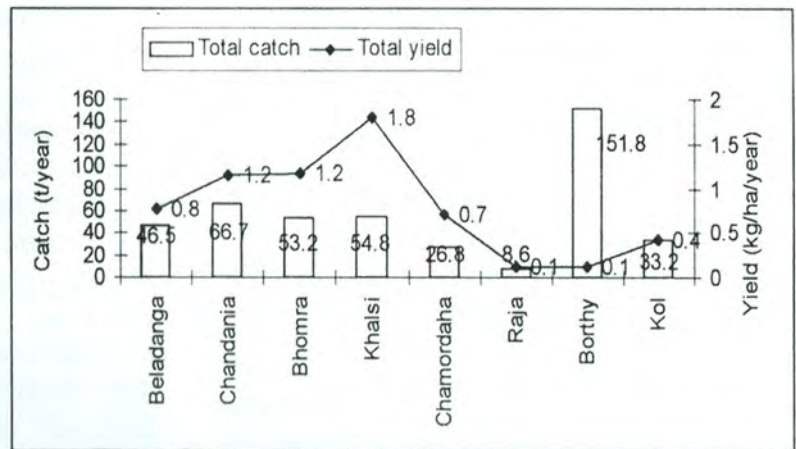


Fig.7. Annual catch (A) and yield (B) of natural fish stock and that of stocked fishes from different wetlands



Rampant catch of fishes: *Puntius* spp. caught using monofilament gill nets (1.8cm mesh) and battery of lift nets along the connecting channel of a wetland.



Fish diversity : A total of 79 species of fin fishes under 57 genera and 32 families have been identified, besides four species of prawns and one species of crab. Fish diversity (Shannon index H') ranged from 1 to 3, richness index (d) ranged from 1.8 to 5.8 and evenness index (j') 0.4 to 0.8 across the systems with higher values for these parameters in wetland with direct riverine connection (Fig.8). Hierarchical cluster analysis on fish species similarity indicating that there are two distinct groups of wetlands, among those studied, at 20% similarity with Kol standing distinct from the rest of the wetlands and at 60% similarity the rest of the wetlands form two groups with Chandania, Bhomra, Beladanga and Khalsi (seasonally connected wetlands with stocking of major carps) forming one group from the rest (Borthy, Chamordaha and Raja) indicating that the fish species spectrum differs among the wetlands.

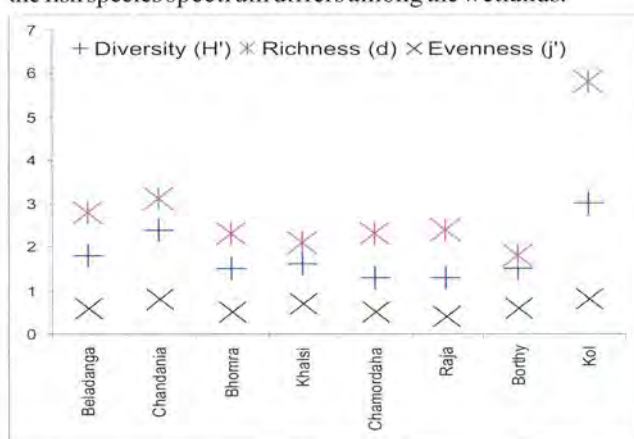


Fig.8 Fish species diversity, richness and evenness indices in different wetlands.

Testing and refinement of fish yield enhancement strategies in floodplain wetlands

Monitoring of stock enhancement in selected wetlands: Five additional wetlands in the Teesta-Torsa basin from Dist Coochbehar, West Bengal were studied to collect various biological, physical and chemical data. Among physical features, all the wetlands are seasonally open type and the area (ha) recorded were 53, 30, 36, 62.75 respectively for Nakkatir Charha, Batrigachi Beel, Chaiter Charha, Naya Charha and Rasik beel.

Phytoplankton primary production revealed that gross primary productions (GPP, $\text{mgcm}^{-3}\text{T}^{-1}$) were 172-289, 86-164, 156-187, 172-391 and 62-70 mg in Batrigachi, Naya Charah, Chaiter Charah, Nakkatir Charah and Rasik beel respectively during 2008, lowest encountered in Rasik beel.

Considering trophic conversion of 1.5 % of planktonic primary production (GPP) the fish production potentials estimated were 1007, 548, 750, 990 and 290 (kg/ha/yr) for Batrigachi, Naya Charah, Chaiter Charah, Nakkatir Charah and Rasik beel, respectively.

Plankton count in these wetlands found to be of lower order, which ranged between 144 u/l in Nakkatir Charah to 275 u/l in Batrigachi beel.

The benthic population ranged between $70\text{--}434 \text{ nos.m}^{-2}$ in these wetlands. Oligochaetes were present in all the wetlands, while bivalves were recorded only in two wetlands.

In general, macrophytes coverage (%) was also of lower order, ranging from 2 - 60 %, with highest being 60% in Rasik beel – a forested wetland. Detritus load ranged from $8.12\text{--}86.8 \text{ g/m}^2$ with highest value recorded in Rasik beel. Most of the wetlands follow stock enhancement as a measure of fisheries management with advanced fingerlings of both IMC and exotic carps, except Rasik beel.

Pen and cage culture

Three different shapes of pen using HDPE material were designed and tested for their durability and growth performance of fishes. The shapes designed were one circular and two rectangular with $100 \times 10\text{m}$ and $50 \times 20\text{m}$ dimensions encompassing 0.1 ha each, which were installed at different location. The two rectangular pens were installed at the margin of the wetland while the circular one was installed at the interior.

Highest fish production ($134\text{kg}/0.1\text{ha}$) was recorded from circular pen followed by rectangular pen ($108\text{kg}/0.1\text{ha}$), having dimension of $50\text{m} \times 20\text{m}$ during 5 months growth trial. During the same period the lowest production ($44\text{kg}/0.1\text{ha}$) was recorded from rectangular pen having dimension of $100\text{m} \times 10\text{m}$. The observed differential growth of fishes was attributed more to the water level fluctuation than to the pen shapes.

All the three shapes of pens were stocked with fingerlings of *L. rohita* and *C. mrigala* at the rate of $50,000/\text{ha}$. Average length and weight of the stocked seed was 8.25 cm and 4.67 g for *L. rohita*; and 8.77 cm and 5.64 for *C. mrigala*. The growth performance of the two species recorded after one month of trial found to be comparable in all the three pens. (Table. 8).

Table 8 . Growth increment(%) of fishes after 30-days in different shapes of pen

Shapes of pen	<i>L. rohita</i>	<i>C.mrigala</i>
Circular	175	180
Rectangular(50x20)	189	177
Rectangular(100x10)	171	169

Trial on stocking density in cages

Eight cages having mesh size 1mm were stocked with fingerlings of major and minor carps at stocking densities of 20, 30, 40 and 50 per m³. The size of the seed was 6.87, 6.1 and 7.4cm in length, and 2.13, 2.09 and 2.95gm in weight, respectively for *L. rohita*, *C. mrigala* and *L. bata*. Fishes were fed with equal proportions of mustard oil cake and rice bran at 6% body weight. During 93 days of experimental trial, the variation in survival and growth increment of minor carp, *Labeo bata* did not indicate any trend with stocking densities. The highest survival was recorded with *L. bata*, which ranged from 83-89%, while growth in terms of percent increment over initial ranged from 344 – 442% without discernible trend. Remarkably, their growth increment in cages was found better than major carp species *C. mrigala* (Table. 9).

Fish yield enhancement in Mahane wetland

Mahane wetland, locally known as 'Mahane Jheel', located on Ganga river basin in Unnao district of Uttar Pradesh is elongate in shape, its depth varied between 1.0 and 2.0 m with an average depth of 1.3 m.

Water quality: Water quality reflects that wetland is highly productive. The water was alkaline (pH 7.4-7.5) in nature and dissolved oxygen was low to high (2.72-11.52 mg/l). Carbonate alkalinity was (Nil-28.0 mg/l) while Bicarbonate alkalinity was high (154.0-398.0 mg/l). Chloride was moderately high (15.62-51.12 mg/l). The water was

moderately hard (136.0-264.0 mg/l) with high specific conductance (309.0-1267.0 $\mu\text{S cm}^{-1}$).

Plankton: Plankton population in the wetland ranged from 280 (post-monsoon) to 1990 ul⁻¹ (summer) with an average of 1173 ul⁻¹. Phytoplankton (83.6 %) productivity was significantly higher with dominance of green algae (30.8%) followed by diatom (24.8%), blue green algae (16%) and Euglenophyceae (12%). Zooplankton represented by Crustacean (6.8%) and rotifers (9.6 %) constituted (16.4%) of the total planktonic abundance.

Periphyton: Periphytic abundance ranged from 570 (summer) and 960 ucm⁻² (monsoon) during the period. In post monsoon, the density was (770 ucm⁻²) recorded. Diatoms (52.5 %) were predominant group followed by green algae (17.5 %), blue-green algae (9.0 %) and Euglenophyceae (12.0 %).

Macrophytes: Infestation of macrophytes was moderate. The wetland shores had luxuriant growth of *Eichhornia* (70%). The wetland had moderate occurrence of *Hydrilla*, *Ceratophyllum* and *Salvinia* 15.0, 8.0 and 7.0%, respectively.

Macrobenthic invertebrates: Macrobenthic abundance ranged from 150 to 603 nm⁻². The biota was dominated by molluscs (77 %) followed by oligochaetes (15.6 %) and insects (7.4%).

Fish seed stocking: Mahane wetland is being stocked in July-August months with fry and fingerlings of Indian major carps (60 %) and exotic carps (grass carp, silver carp and common carp). As per the society's information, about 4.5 lakh seed had been stocked in the wetland during July-August, 2008. Auto-stocking of cultured species was not reported in the wetland.

Fish diversity: The wetland harbors rich fish diversity, besides, stocked IMC and exotics, a total of 23 fish species were recorded from the wetland during the period. These are

Table 9. Growth (% increment over initial) performance and survival of different species at different stocking densities

Species	Stocking densities							
	20 nos/m ³		30 nos/m ³		40 nos/m ³		50 nos/m ³	
	Growth	Survival (%)	Growth	Survival (%)	Growth	Survival (%)	Growth	Survival (%)
<i>L. rohita</i>	508	77	477	71	471	69	360	67
<i>C.mrigala</i>	235	69	283	72	376	65	393	70
<i>L. bata</i>	344	87	378	83	340	89	422	83



Labeo rohita, *Catla catla*, *Cirrhinus mrigala*. *Labeo bata*, *Labeo gonius*, *Ctenopharyngodon idella*, *Cyprinus carpio communis*, *Wallago attu*, *Clarias batrachus*, *Heteropneustes fossilis*, *Aorichthys seenghala*, *Aorichthys aor*, *Mystus vittatus*, *Ophiocephalus marulius*, *Ophiocephalus striatus*, *Salmostoma bacaila*, *Salmostoma laubuca*, *Chanda nama*, *Nandus nandus*, *Colisa fasciatus*, *Cirrhinus reba*, *Puntius ticto* and *P. sarana*.

Fish yield: Approximately 11.7 tones of fishes were harvested from October to December, 2008. The fish species contributed in catch comprised mainly *Catla catla* 20%, *Labeo rohita* 35%, *Cirrhinus mrigala* 5% and *Ctenopharyngodon idella* 25%. Miscellaneous species and cat fishes (15 % in total) have not contributed significantly.

Fish stock management and enhancement protocols for sustainable fisheries in NE states

Damal beel (Assam)

It is a closed beel having water-spread area 20 ha. Rohu was predominantly stocked followed by catla, grass carp, common carp, mrigal. In addition, about 100 seed each of *C. chitala* and *A. seenghala* have been released. The species ratio of 3 surface feeders: 2 column feeders: 1 bottom feeders for the carp species has been suggested for beel. A total of 7000 advanced fingerlings (average stocking size 200 g) were released during September-October after the monsoon run-off receded. The beel was deliberately understocked (stocking density 525 no./ha) so that the thriving natural fishery of *Gudusia chapra* (a small Clupeid species having high consumer demand and price) that contributes to approximately 10% of the total fish yield of the beel sustains. Water of the beel had moderate temperature (20.7-21.5°C), high Secchi disc visibility (0.77-0.95 m), alkaline pH (7.1-8.2), optimal dissolved oxygen (7.6-8.4 mg l⁻¹), low free carbon dioxide (2.0-3.0 mg l⁻¹), low total alkalinity (19-23 mg l⁻¹) and moderate specific conductivity (40-44 µS cm⁻¹).

The beel is relatively free from infestation of aquatic macrophytes; an estimated 5% of water surface was infested by macrophytes. The main constituents of macrophytes were submerged plants (*Potamogeton* sp.), followed by rooted emergent (*Euryale ferox*) and free-floating plants (*Eichhornia crassipes* and *Salvinia molesta*).

Numerical abundance of plankton in the beel was low (82-

113 ul⁻¹). Dominance of phytoplankton (76.92-92.31%) was observed. Among phytoplankton groups, Chlorophyceae (33.33-40%) was the dominant group followed by Bacillariophyceae (33.33-38.46%) and Myxophyceae (15.38-40%). Zooplankton was represented by Protozoans (0-15.38%) and insect larvae (7.69-10%).

Korkoria beel (Assam)

It is a closed beel in Cachar district under the administrative control of the Assam Fisheries Development Corporation. A tentative species ratio of 2 surface feeders: 1 column feeder: 1 bottom feeder has been suggested for the beel. The suggested species ratio has been further split into 30% catla, 20% silver carp, 15% rohu, 10% *Labeo gonius*, 15% common carp and 10% mrigal. This moderate sized beel (effective water-spread area 50 ha) has been under stock enhancement for over 10 years. The fish yield rate in this beel was 400 kg ha⁻¹ yr⁻¹, out of which only about 10% was contributed by small-sized low value fishes.

Effect of macrophyte on biotic and abiotic parameters of beel ecosystems in Assam

A mesocosm experiment was performed in Samaguri beel, Nagaon, Assam to understand the effect of different types of aquatic macrophytes on wetland production functions like physico-chemical properties of water, enzymes and biochemical properties of soil and concentration and quality composition of biotic communities like plankton, periphyton and macro-benthos. The beel was thickly infested with all types of macrophytes especially *Trapa* sp., water hyacinth, *Salvinia* sp., *Azolla* sp., *Hydrilla* sp. etc. A total number of six enclosures (10 x 10 m²) were constructed in the beel by clearing all types of macrophytes in selected location with 1.1 m depth. Floating macrophyte water hyacinth was kept in three enclosures, whereas submerged macrophytes (*Hydrilla* sp., *Ceratophyllum* sp., *Vallisneria* sp., *Najas* sp. etc) were kept in other three chambers. All the beel production function parameters were monitored during the experiment at different point of time. Salient findings with respect to different health and biodiversity parameters during the monitoring were as follows:

Physico-chemical properties of water: Significant differences were noted in water quality parameters like

Table 10 Variation of different physico-chemical properties of water (130th day)

Macro-phyte type	Depth (cm)	Water temperature (°C)	Water pH	Sp. conductivity (µS/cm)	ORP (mV)	Free CO ₂ (mg l ⁻¹)	Dissolved oxygen (mg l ⁻¹)	Total alkalinity (mg l ⁻¹)	BOD (mg l ⁻¹)
Submerged	77	25.6	8.50	175.5	+80.5	Nil	12.80	83.5	1.75
Floating	77	22.0	7.20	184.3	+118.3	22.0	5.43	87.0	4.55

transparency, water temperature, pH, specific conductivity, free CO₂, dissolved oxygen, total alkalinity, BOD etc between enclosures with submerged and floating macrophytes (Table 10). Enclosures with floating macrophytes were characterized with lower transparency, water temperature, water pH, DO, and higher sp. conductivity, free CO₂, BOD as compared to enclosures with submerged variety. Enclosures with floating macrophytes contained less amount of available PO₄³⁻ and available SiO₃²⁻ as compared to enclosures with submerged macrophytes.

Enzyme and associated biochemical properties of soil: Soil samples were collected during sampling on 40th day and 90th day of the experiment. Sediment microbial dehydrogenase

and acid phosphatase activity increased during both the time of monitoring with higher values in submerged than floating type of macrophyte (Table 11). Fibre degrading enzyme, β-glucosidase activity decreased during both the time of monitoring with higher decrease in floating than submerged one while alkaline phosphatase showed reverse trend of decrease during both the time. Although soil reaction did not change during 40th day and 90th day due to macrophyte type but increasing trend was observed with time (Table 12). Organic matter showed decreasing trend with progress of experiment showing lower value in submerged than floating type of macrophyte. Higher value of specific conductivity was observed for submerged one during 40th day with no variation during 90th day.

Table 11. Effect of macrophyte on soil enzyme

Time	Type of Macrophyte	Dehydrogenase (µg formazan g ⁻¹ dry soil h ⁻¹)	Acid Phosphatase (µg pNPG ⁻¹ dry soil h ⁻¹)	Alkaline phosphatase (µg pNPG ⁻¹ dry soil h ⁻¹)	B-glucosidase (µg pNPG ⁻¹ dry soil h ⁻¹)
40 th day	Floating	29.77	590.27	365.68	407.44
	Submerged	35.53	658.42	393.06	463.18
90 th day	Floating	42.85	572.53	394.57	305.89
	Submerged	49.66	609.81	375.42	406.75



Table 12. Effect of macrophyte on soil parameters

Time	Type of Macrophyte	Soil pH	Organic matter (%)	Specific conductivity ($\mu\text{S}/\text{cm}$)
40 th day	Floating	6.85	17.79	342
	Submerged	6.84	17.77	364
90 th day	Floating	7.05	17.10	362
	Submerged	7.05	16.73	361

Plankton, periphyton, benthos, macrophyte-associated fauna: Plankton concentration increased during 40th and 90th day due to both types of macrophytes with higher increase due to floating than submerged type. Higher numbers of benthic organisms was noted in submerged type of macrophyte than floating with more concentration during 40th day than 90th day. Significant variation of periphyton population in terms of biomass and count was observed due to two types of macrophytes during both the time. Higher concentration of periphyton both in counts and biomass was noted in submerged macrophytes than floating type with more in 40th day than 90th day.

Socio-economic evaluation and delivery mechanism in floodplain wetlands of Assam

Property and Water regime of selected wetlands: Socio-economic evaluation of six beels namely Damal, Charan in Morigaon district, Rawmari in Nagaon district and Kapla, Barkana and Puthimari beel in Barpeta district was done in 2008-09 (Table 13).

Production and productivity of selected beels: The production and productivity of the selected three wetlands have increased sharply after adoption of stock enhancement measures in beels (Table 14). The productivity of the capture fisheries beel was very low in comparison to the beels having culture based fisheries. Natural fish stocks percentage predominates in both the capture fisheries beels and contributes thirty to fifty percent in all culture based fisheries beels.

Economics of beel fisheries management: The economics of beel fisheries revealed that in better managed beel, the fixed cost was around twenty percent, whereas in bad managed beels the fixed cost has increased significantly. The analysis also revealed that the individual managed beels have more net profit and high benefit cost ratio than cooperative managed beels. Individual managed culture based beels like Puthimari, Rawmari and Damal had given a high B: C ratio of 3.64, 3.73 and 2.92 respectively, whereas the B: C ratio for cooperative managed beel Charan was only 1.92.

Table 13. Property and water regimes of selected floodplains wetlands

Beel	District	Avg. Size (ha)	Owner ship	Lease		Fishing regime	Water regime	Type of beel
				Rent (Rs.)	Period			
Rawmari	Nagaon	25	AFDC	66,000	7	Private	Perennial	Open
Damal	Morigaon	20	AFDC	51,000	7	Private	Perennial	Closed
Charan	Morigaon	60	AFDC	2,55,000	7	Coop	Perennial	Open
Kapla	Barpeta	91	AFDC	3,00,000	7	Private	Perennial	Semi Open
Barkana	Barpeta	226 (40)	AFDC	2,75,000	7	Private	Perennial	Open
Puthimari	Barpeta	60	AFDC	54,000	7	Private	perennial	Closed

Table 14. Production and productivity of selected wetland

Beel	Production (kg)	Productivity (kg ha ⁻¹ yr ⁻¹)
Rawmari	17000	850
Damal	20600	1030
Charan	24650	411
Barkana	8000	35
Kapla	10000	110
Puthimari	28500	475

Contribution of Beel fisheries in State Domestic Product:

Fisheries contribute two percent of the state domestic product of Assam. Beels fisheries contribute twenty six percent of the total state fisheries production. But when we take the income from fisheries, the share of beel fisheries is almost equal to aquaculture because the fish catch from the beels fetches better price than fish produced from pond. The combined production of Beels and derelict water bodies contributes around 44% of the income from fisheries and around 0.9 % in SDP of Assam. Hence, the contribution of beel fisheries to state domestic product was far more than any other fisheries.

GIS application for assessment of wetlands in different districts of Assam

During 2008-09, floodplain wetlands (beels) located in twelve districts of Assam viz. Barpeta, Baska, Bongaigaon, Dhubri, Dibrugarh, Goalpara, Golaghat, Jorhat, Kokrajhar, Sibsagar, Sonitpur and Tinsukia were surveyed for fishery resource assessment. A total number of 370 beels (including some large tanks) surveyed in those 12 districts covering an approximate area of 12280 ha. This is in addition to already surveyed 184 beels in Kamrup (62), Nalbari (9), Darrang (17), Morigaon (45) and Nagaon (51) districts of Assam during 2006-07 and 2007-08. Data were collected on location, latitude, longitude, area, shape, water depth, water retention period, river connectivity, macrophyte infestation, lease details, fishing rights, supplementary stocking status, annual fish catch, species composition in the catch and available fish species, existing fishing gear etc.

A total number of 351 out of 370 (94.9%) beels retained

water throughout the year. On the other hand, 306 beels out of 370 (82.7%) still maintain riverine connection and are connected with the parent river either seasonally or perennially. However, in many beels the connecting channels are controlled by sluice gate.

Floating macrophytes especially water hyacinth is a menace in many wetlands of Assam. Data revealed that beels in less flood-prone districts like Barpeta, Jorhat, Sibsagar are more infested with floating macrophytes with the highest in Sibsagar district with 53.5% of beel area are choked with them. On the other hand, beels in districts like Baska Bongaigaon, Dhubri, Tinsukia are less infested with floating macrophytes. Out of 356 beels, macrophytes are reported to be cleared in 166 beels (46.6%) with highest percentage in Golaghat district. A maximum number of beels (29 out of 32 beels) in Golaghat district observed macrophyte clearance as reported.

Supplementary stocking is often recommended as a fishery enhancement measure to augment fish production from beels. A total of 70 beels out of 370 beels (18.9%) surveyed are observed supplementary stocking support. Fishing is performed in most of the beels except few which are either under reserved area or having some conflicts or litigation. Most of the beels are leased for fishing rights for different years depending upon the leasing authority.

Data on fish species available, occurrence and sources of exotics, fish catch composition under broad groups, major fishing gear employed with harvesting potential and major problems identified for fisheries development were also collected. Collected data have been digitized for preparation of GIS on wetlands of Assam.

Fish stock assessment of River Brahmaputra

The following 43 fin-fish species including elvers of the catadromous migratory eel, *Anguilla bengalensis* (hitherto unreported from this centre) were recorded at Uzanbazar landing centre of river Brahmaputra. The other species recorded were *Gudusia chapra*, *Tenualosa ilisha*, *Aspidoparia morar*, *Osteobrama cotio cotio*, *Esomus dandricus*, *Amblypharyndon mola*, *Chela laubuca*, *Barilius barila*, *Puntius sophore*, *P. ticto*, *Labeo bata*, *L. rohita*, *L. gonius*, *L. calbasu*, *L. dyocheilus*, *L. dero*, *L. stoliczkae*, *Catla catla*, *Cirrhinus mrigala*, *C. reba*, *Lepidocephalus guntea*, *Nemacheilus rupecola*, *Setipinna brevifilis*, *Mystus*



vittatus, *Wallago attu*, *Aorichthys aor*, *Rita rita*, *Ailia coila*, *Gagata cenia*, *Pseudotropius atherinoides*, *Eutropichthys murius*, *Heteropneustes fossilis*, *Chanda nama*, *Sicamugil cascasia*, *Colisa fasciatus*, *C. labiosus*, *Glossogobius giuris*, *Pama pama*, *Nandus nandus*, *Channa punctatus*, *Macrognathus pancalus* and *Xenentodon cancila*. Small but economic fin-fish species like *A. morar*, *A. coila*, *P. atherinoides*, *C. reba*, *G. chapra*, *Puntius* spp. and *Mystus vittatus* were dominated the landings at this centre indicating decline in abundance of major carp and catfish species apparently because of their selective over-fishing and/or disruption of the natural stock replenishment process of major fishes. *A. morar* was the single most dominant species at both the landing centres during the study period.

Estimation of fish catch: Fish landing data were collected at Uzanbazar fish assembly center of River Brahmaputra during the period from April to December, 2008 following systematic sampling design. The estimated total fish catch during the period was 69493 kg. During April-May, fish landings at the centre were in the range of 8292-8255 kg, which registered an upward trend from June to reach peak catch of 9540 kg during September. Fish catch drastically declined to 3108 kg during October after which landings again increased to reach 8944 kg during December. There were variations in fish catch composition between among different months. *Aspidoparia morar* was the single most important species in all the months except during the early part of monsoon season (June-July). The gangetic prawn (*Macrobrachium gangeticus*) replaced *A. morar* as the single most important species contributing to total fish landings during June-July. The anadromous migratory fish, *Tenualosa ilisha* considerably contributed to landings to become the second most important fish species during November (15.4% of total catch). Similarly, loaches (mainly *Lepidocephalus guntea* and *Botia dario*) were landed in significant quantities only during July to September indicating that this the period for their downward migration from tributaries to the main river. Considerable quantities of juveniles of the Indian major carps (including *Labeo calbasu*) were landed during August, immediately after the peak flood occurred in the river. The other commercially important fish species/groups recorded at the landing centre during the period were

minor carp (*L. gonius*), major catfishes (*Wallago attu*, *Aorichthys seenghala*, *Rita rita*, *A. aor*), featherbacks (*Chitala chitala*, *Notopterus notopterus*), and minor catfishes (*Clupisoma garua*, *Mystus vittatu*). The miscellaneous species recorded during the period were *Puntius* spp., *Colisa* spp., *Pseudotropius atherinoides* and *Glossogobius giuris*. In addition, *M. cavasius*, *Ompok pabda*, *Gagata cenia* and *Eutropichthys vasa* appeared in the catches during November-December.

FISH HEALTH & ENVIRONMENT

Developing fish-based indicator tools for environment monitoring

During the reported period investigation was conducted in six sites viz., Jamalpur (DS1), Randiha, (DS2), Ashish nagar (DS3), Namo-mejia (DS4), Burnpur (DS5), and Panchet (DS6) covering 123 km stretch of river Damodar. DS1 was the reference site upstream and DS6 the reference site downstream. DS2 to DS5 were the stressed sites.

Environmental status

The industrial establishments along this stretch are a) Coal mines b) Coal washery, coal handling and coke oven plants c) Thermal power station d) Steel plant e) Fertilizer, cement and chemical industry.

Water pH of river Damodar was found alkaline range 7.46 – 8.96 (average 8.16). Conductance of the river water was found in the normal range of 151 – 348 $\mu\text{S cm}^{-1}$ (average 235 $\mu\text{S cm}^{-1}$). The Panchet reservoir water exhibited higher values of conductance. The Barakar river water having relatively lower conductance (due to less content of dissolved salts, detected conductance 175 $\mu\text{S cm}^{-1}$ during summer months) reduces the Damodar water conductance. The effluents of Durgapur industrial complex had relatively high sp. conductance with recorded value of 444 $\mu\text{S cm}^{-1}$ during summer months. Dissolved oxygen was found above the desired level of 5 ppm in all the sampling sites irrespective of the sampling seasons. BOD and COD values were found not very critical but BOD values > 4 ppm were recorded (maximum 5.2 ppm at Jamalpur stretch). Moderate content of phosphate was noticed in the river stretch, but many a time the levels were detected in traces (range 0 – 0.07 ppm). Detected phosphate level is indicative of effluent water entry into the river system. In some cases presence of

free ammonia was also noticed, though not in higher content ((observed range 0 – 0.23 ppm). The highest content recorded at Burnpur where the river receives significant amount of industrial effluents.

The sediment mean pH ranged between 7.0 to 7.8. Burnpur site recorded highest pH. Organic carbon content was low, mean value ranged between 0.11 and 0.32 %. Highest value recorded at Durgapur site. Mean available phosphorus (as P) level ranged between 29 – 42 mg kg⁻¹.

The status of Cd and Pb in the sediment of river Damodar was in traces whereas Zn and Cu content ranged between 15.7 and 64.9 and 4.0 and 19.6 mg kg⁻¹ respectively. The metal content in river Damodar water samples exhibited absence of any appreciable amount of the studied metals (Cd, Cu, Mn, Pb and Zn). The status of Cd and Pb in sediment was in traces whereas Zn and Cu ranged between 17.0 – 35.0 and 6.0 – 19.2 mg kg⁻¹ respectively.



A view of Industrial effluent releasing tunnel from Durgapur Industrial Complex



The flowing of effluent through cemented canal from thermal and steel power plant at Durgapur.

The accumulation of Cu, Cd and Pb in the flesh of *A. seenghala* and *C. mrigala* of river Damodar was in traces and that of Zn ranged between 2.0 and 2.31 mg kg⁻¹ (wet fish), which is below the permissible limit for human consumption.

The detected levels of arsenic were found in traces in the fish samples. Although in the sediment, As content was noticed in the range of traces to 2.05 ppm, the levels were much below than that found in the arsenic-affected areas (found up to 28 ppm). Water quality parameters reflected the anthropogenic activities with moderate values of BOD and phosphate content.

Occurrence of 4,4'-DDTs was noticed in all the water samples analysed which was detected up to 9.5 ppt or ng l⁻¹ which exceeded the permissible limit (1 ppt) of EPA (USA) for aquatic life.

Biotic status

Fish community studies: Fish samples were collected from all the sites by experimental netting of all the different habitats for fishes using different gears. The fish species abundance were also recorded and all the fishes were classified into the various guilds for measuring the 12 metrics of IBI. 56 fish species belonging to 22 families obtained from 5 stretches of river of Damodar were categorised into the habitat, trophic and tolerance guilds and into the 12 metrics of IBI. Based on fish assemblages the scoring system in terms of ecological integrity is being developed.

Fish Health Assessment Index (HAI): The quantitative health assessment index for rapid evaluation of fish condition in the field was done to evaluate the general health status of fish populations in river Damodar from a polluted and a reference site. High HAI was recorded in *L. bata* at Durgapur compared to reference site indicating fish population under stress

Table 15: Health assessment index values of *Labeo bata* from river Damodar

Damodar river	HAI (mean)	SD	CV %
Jamalpur (reference site)	14.67	15.52	105.80
Durgapur (degraded site)	46.67	31.55	67.60

Plankton: the phytoplankton concentration in river Damodar varied in the range of 139 unit l^{-1} among the six sampling stations. Abundance of pollution tolerant phytoplankton species was recorded as *Namo-Mejia* (165 ul^{-1}) > *Durgapur* (157 ul^{-1}) > *Burnpur* (122 ul^{-1}) > *Randiha* (113 ul^{-1}). Based on the obtained Variety Index ($d=0.052$), Evenness Index ($J=0.048$) and Shannon Index ($H=1.601$) of zooplankton, the sampling site *Namo-Mejia* can be considered as the most organically polluted site among all the investigated stations.

Benthos: The benthos varied in the range of 137 Nos. m^{-2} among the investigated sites. The dominance of Molluscs at Jamalpur, Randiha and Panchet has indicated development of β -mesosaprobic condition in the bottom with light pollution; where as Annelid from Durgapur to Burnpur has proved severe bottom pollution.

Periphyton: The range of periphyton variation was 263 organisms cm^{-2} among the sampling stations. Based on Bacillariophyceae domination (36.0% to 54.7%) in total periphyton, the water bodies from Randiha to Burnpur can be considered as organically polluted.

Microbial enzyme activities : In present year the protocols for estimation of phosphatase (ALP) and β -Glucosidase (β -Glu) were further miniaturized to 96-well microplate format. Salient features of the methods are:

Minimum sample volume: Minimum 200 μl water and 0.5g of soil samples are required (as compared to 5-10 ml water and 5-10 gm sediment used in most published literatures).

Suitable blank for water enzyme assays: Individual water sample was boiled to give exact/appropriate blank for respective test water sample.

Suitable blank for sediment enzyme assays: Pooled-and-autoclaved sample soil

Best reaction time for the enzyme assay: One hour for phosphatase and dehydrogenase, 2 h for β -glucosidase (as compared to 4-48 hrs used for samples from temperate regions).

Substrate concentrations for zero-order enzyme reaction: For zero-order kinetics, V_{max} and K_m determination, substrate saturation level estimation is the most important step. In present study, after determining presumptive V_{max}

for pooled water or soil sample, each sample was reacted with narrow range of substrate concentrations to obtain enzyme product at saturation substrate concentration. [S] used for water phosphatase: 103.7-1222 μM , [S] used for water β -glucosidase: 50-703.7 μM , [S] used for soil phosphatase/ β -glucosidase: 500-2000 μM

Overall, a rapid fluorometric protocol based on 96-well microplate format was developed for determining enzyme activity in aquatic environments using low amount of sample and fluorogenic substrates.

Phosphatase and β -Glucosidase enzyme activities: The results (Fig 8,9) indicated that both phosphatase and β -Glucosidase enzyme activities and microbial respiration decreased in the Burnpur, Raniganj and Durgapur industrial areas, possibly as an impact of industrial pollution on the river microbial community. The microbial activities slowly increased indicating recovery in the downstream. Unlike phosphatase, water β -Glucosidase activity was not markedly altered: high activity in Durgapur was due to heavy macrophyte growth above Durgapur barrage. There were wide variations in activities in different samplings and are possibly the seasonal variations.

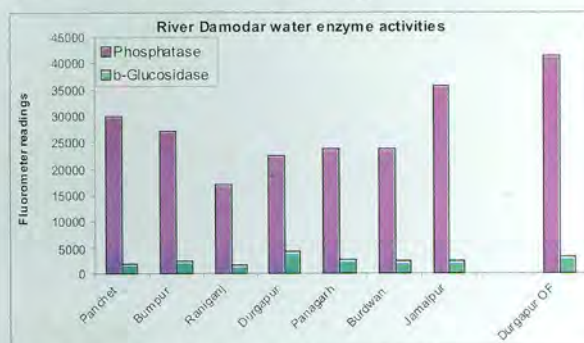


Fig. 8. Water ALP and β -Glucosidase activities

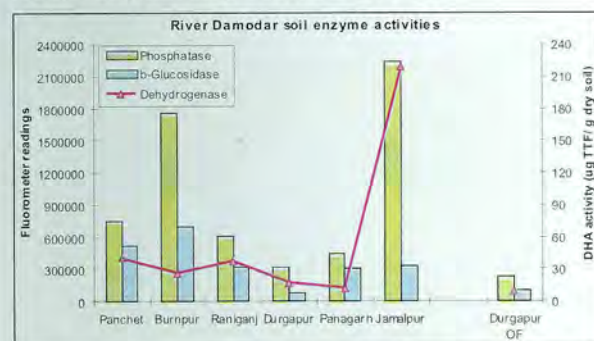


Fig. 9 Sediment phosphatase, β -Glucosidase and dehydrogenase activities

Microbial diversity: Water and sediment samples from different sites along Damodar river system were analyzed to assess the microbial load. Microbiological analysis was used to estimate for following parameters: a) Total aerobic heterotrophic bacteria count (TPC), b) Total *Vibrio* count (TVC), c) Total *Aeromonas* count d) Total coli/ *E.coli* count and e) *Pseudomonas* count. The Results indicated high microbial load in sediment samples collected from Durgapur, Burnpur & Panchet, indicating higher level of pollution. TPC values were less in samples collected from Jamalpur and Panagarh. Load of *Aeromonas* was low in most samples except those collected from Durgapur & Burnpur. Comparatively low *Pseudomonas* count was observed in water and sediment samples, with higher load in samples collected from Durgapur, Ranigunj and Burnpur.

Molecular typing of *Aeromonas*: The main objective of molecular typing was to measure the genetic diversity of *Aeromonas* isolates using 3 genotyping methods a) Repetitive DNA sequence genotyping (Rep-PCR) using BOX primers (BOX- PCR), b) Enterobacterial repetitive intergenic consensus based-polymerase chain reaction (ERIC-PCR) primers and (c) 16SrDNA sequencing and analysis. Multinucleus sequence typing (MLST) a new technique of genotyping was also tried. The BOX-PCR and ERIC-PCR fingerprints were obtained using a boxA1R primer (5' CTACGGCAAGGCGACGCTGACG 3'), ERIC1 R (5' ATG TAA GCT CCT GGG GAT TCAC3') and ERIC2 F (5' AAG TAA GTG ACT GGG GTG AGC G 3'). The rep-PCR genomic profiles were normalized using BioNumerics software version 4.0. The discriminatory power of the two rep-PCR methods was estimated by application of the Simpson numerical index of diversity. All the isolates were further PCR amplified for 16SrDNA using following primers: forward primer 27f: 5'- AGA GTT TGA TCM TGG CTC - 3' and reverse primer, 1495r 5'- CTACGGCTACCTTGTTACG -3'. Besides these all *Aeromonas* isolates were screened using Aerolysin gene 'aer' PCR and cytotoxic hemolysin 'AHCYTOEN' gene PCR. A total 77 *Aeromonas* 16S rDNA sequences and 77 + 21

Aeromonas 'aer' & 'ahcytoen' genes were included in the phylogenetic analysis. Results indicated that 16S rDNA sequence analysis to be more suitable for identification and differentiation of bacterial isolates. The 'aer' & 'ahcytoen' gene sequences of these American isolates were compared with similar sequences of *Aeromonas* isolates collected from West Bengal, India. Comparative sequence analysis indicated wide genomic variation between West Bengal isolates and those collected from different parts in USA and they made two distinct groups. The nucleotide sequences of all *Klebsiella* and *Aeromonas* isolates have been submitted to NCBI GenBank.

Gene expression studies in *Labeo bata* exposed to 17- β Estradiol

Labeo bata male fishes were exposed to 17- β -Estradiol (Sigma, USA) at a concentration of 100 $\mu\text{g l}^{-1}$ dissolved in DMSO for 48 hours at room temperature. The fishes were killed after 48 hrs and RNA was extracted from liver. A Reverse transcriptase-PCR was done using Qiagen-PCR kit. The *Cyprinus carpio*/*Barbus graellsii* (Garcia-Reyero, *et. al.*, 2004) vitellogenin gene specific primer (5'-TCTGTGTTGATGGTGCTCTGCTG-3', 5'-TGGAAAGCCGCATATAGATGTG-3') was used to partially amplify the *Labeo bata* vitellogenin gene. The 130 bp region of the vitellogenin gene expression was observed in the individuals which were exposed to 17- β Estradiol and is not expressed in those fishes which were not treated with 17- β Estradiol. The cross species gene specific primer from *Cyprinus carpio*/*Barbus graellsii* was used to amplify this region and it was found that the primer amplified a 130 bp region of *Labeo bata* vitellogenin gene. The vitellogenin gene under normal conditions is not expressed in male fishes therefore detection of the transcriptional switch that results in the onset of vitellogenin mRNA provides a sensitive indicator for exposure to estrogenic compounds (Lattier, *et. al.*, 2002). Thus the vitellogenin gene expression in males fishes exposed to estradiol indicate the endocrine disrupting effect on the Indian minor carp *Labeo bata* and can be used in bioassessment of aquatic pollution.



Microbial degradation ability of phenol & phenolic compounds

A total of 24 bacterial strains capable of degrading/utilizing either phenol, resorcinol, chloromethylphenol, 4-chlorophenol, or pentachlorophenol have been isolated in pure culture. No bacteria capable of metabolizing 2,4-dichlorophenol could be isolated from these sites. The strains isolated from Haldia industrial area were highly resistant to phenol (≥ 1000 ppm) and pentachlorophenol (~ 300 ppm – highest solubility of PCP in culture media). The bacterial strains are preserved for further studies.

Table 16: Phenol degrading bacterial strains isolated from polluted sites during 2008-09

	Durgapur	Raniganj	Haldia
Phenol	Done in 2007-08		7
Resorcinol	Done in 2007-08		6
4-chlorophenol	0	0	1
2,4-Dichlorophenol	0	0	0
4-chloro-2-methylphenol	1	0	4
Pentachlorophenol	2	1	2

Protein characterization of selected microbes

The identified microbes with phenol degrading activities were selected for protein characterization. As the degradation of any chemical depends on the enzymatic pathways of microbes which act on these substrates, the selected microbes were allowed to grow under different concentration of pollutant in the selected media. After overnight growth, the microbes were used for isolation of proteins. From control condition to lethal concentration of phenol, the growth of bacteria was recorded. The seven different conc. (from 00ppm to 1000ppm of phenol) were used by taking two imp. bacteria and proteins were prepared from all of them. The proteins were analysed on 1D & 2D gels and staining were done with Coomassie.

Stress mediated genetic contamination in fishes

Puntius ticto, *Xenentodon cancila*, *Gadusia chapra* were sampled from different locations on the river Damodar representing the upstream reference site with low pollution, Industrial polluted site and downstream of industrial site. Sites sampled were Panchet, Burnpur-Raniganj, Durgapur at Ashis nagar and below barrage, Burdwan and Jamalpur. The 8 RAPD-PCR oligo-degenerate primers were used for amplification of genomic DNA. Each primer was found to be highly polymorphic and the number of fragments amplified was large. The RAPD patterns were generated for all the samples collected from the above-mentioned locations. These fragment patterns were then analyzed for the presence and absence of amplified bands.

The DNA was also used to amplify the mitochondrial DNA genes. Several genes were amplified, cytochrome b gene, Cytochrome oxidase II, 16S rRNA gene. The cytochrome b gene amplification resulted in a amplification fragment of 360 bp. This 360 bp DNA fragment from *P. ticto*, *Xenentodon cancila* and *Gadusia chapra* were sequenced. The genomic DNA of the fish species namely *Labeo angra*, *Gadusia chapra*, *Xenentodon cancila* was extracted from the fishes and subjected to mtDNA sequence analysis. The cytochrome b, Cytochrome oxidase II, control region genes were targeted for amplification of these genes in the various fishes. The control region was amplified in only *G. chapra* and not in *X. cancila*, *Labeo angra*. The cytochrome b gene was amplified in *Labeo angra*, *X. cancila*, *G. chapra* and *Puntius ticto*, which were DNA sequenced. The sequencing results yielded 300 bp data for each species.

Metallothionein Biomarker Gene expression studies in *Labeo bata* exposed to CuSO_4 : *Labeo bata* young fishes were exposed to three different concentrations of CuSO_4 dissolved in 30 liters of water along with a control experiment in which the CuSO_4 was not added. Ten numbers of fishes were exposed to 3 different concentrations; 0.5mg/lit, 3mg/lit, and 8mg/lit. Two different set of metallothionein specific gene primers were utilized for detection of the expression of two different isoforms of metallothionein genes. The control fishes did not express the metallothionein genes as indicated by

absence of cDNA amplification product. Detectable gene expression of metallothionein gene was observed at the 8mg/lit concentration of Copper Sulphate. The appearance of metallothionein gene indicates the effect of metal pollution of fish physiology at the molecular level.

Fish proteomics

Aorichthys seenghala was collected from different sites viz. Panchet, Namamejia and Durgapur etc. in river Damodar. *Rita rita* were collected from river Ganga. Tissue proteins were analyzed by employing various contemporary techniques like: 1- and 2-dimensional gel electrophoresis (1- and 2-D GE), 1- and 2-immunoblot analysis etc.

SDS-PAGE profiles of tissue proteins of *A. seenghala* was done (Fig11). HSP70 expression was detected in liver, kidney, gill and white muscle of *A. seenghala* by employing 1-D immunoblot analysis. HSP70 is expressed in muscle, liver, gill and kidney tissues of *A. seenghala*; however, the level of expression is different. There is high level of HSP70 expression in gill and white muscle tissues and low level of expression in kidney and liver. The HSP70 proteins detected appears to be constitutive HSPs. Inducible HSP70 forms are being studied by using immunoproteomics technology. 2-D immunoblot and immunoproteomic analyses are being carried out to detect the different members of this family (constitutive and inducible forms) to test its suitability as a 'biomarker' for aquatic environmental monitoring under tropical conditions.

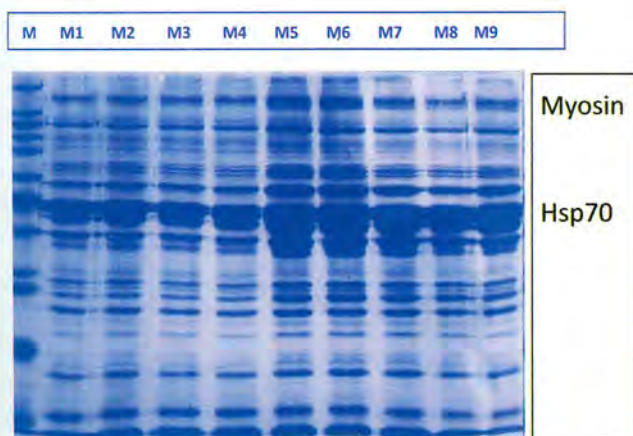


Fig.11. 12% SDS-PAGE profile of *A. seenghala* muscle proteins



Fig 12. Immunoblot showing HSP70 proteins in muscle, liver, kidney and gill tissues of *A. seenghala*. *Rita rita* white muscle as +ve control.

Expression profile of HSP70 in different fishes: Expression profile of HSP70 in different fishes: **Expression profile of HSP70** was also studied in muscle, liver, kidney, gill tissues of other important tropical freshwater fishes, viz. *Rita rita*, *Anabas testudineus*, *Channa punctatus*, *Labeo rohita*, *Cirrhinus mrigala* and *Cyprinus carpio* (Table 15). Proteins were analyzed by SDS-PAGE and the HSP70 were analyzed by Western-blot analysis. HSP70 expression was detected in all the four tissues of *A. seenghala* and *Rita rita*; however the expression was higher in muscle and liver tissues and low in the kidney and gill tissues. The protein was detected in the liver and gill tissues of *A. testudineus* and only in the kidney tissues of *C. punctatus*. Similarly, in the IMC L. *rohita* HSP70 was detected in muscle, kidney and gill tissues where as in *C. mrigala* the protein was expressed in liver and gill tissues only. In case of the exotic carp *Cyprinus carpio*, HSP70 was detected in all the tissues analyzed except gill. The samples are under analysis by 2-D gel electrophoresis and 2-D immunoblotting for identifying the inducible and constitute forms of the protein. *Lens proteome map and α-crystallin profile of tropical freshwater catfish Rita rita*: In the present study, proteome map for the tropical catfish *Rita rita* crystallins have been generated. Other than zebra fish, much information is not available on such aspects of any other fish species. □A-crystallins have been identified by employing 1- and 2-D immunoblot techniques. Comparative lens proteome maps are being generated for *R. rita* collected from polluted and reference sites of the river Ganga in search of pollution biomarkers. (Fig 13, 14,15)

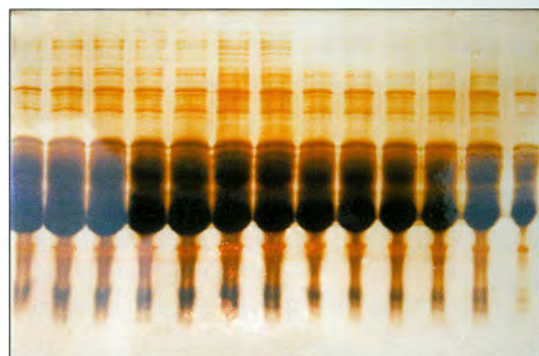


Fig 13. 15 % Silver stained gel showing the low abundant crystallins. The high abundant proteins are over developed

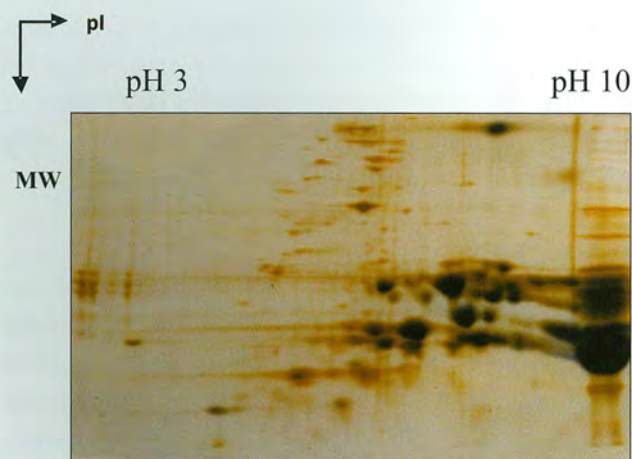


Fig 14. Lens proteome maps of *Rita rita*. Silver- stained 2-D gels (12%) showing crystallin spots.

Antimicrobial Peptides from Skin Mucus of Fish: The protocols for isolation of antimicrobial proteins (AMP) from fish (*Labeo rohita* and *Rita rita*) skin mucus by a proteomic approach was standardised.

Table 17 . HSP70 Expression in different tissues of some teleostean fishes

<i>Fish species</i>	<i>Liver</i>	<i>Muscle</i>	<i>Kidney</i>	<i>Gill</i>
<i>Labeo rohita</i>	-	++	++	++
<i>Cirrhinus mrigala</i>	++	-	-	++
<i>Cyprinus carpio.</i>	++	++	++	-
<i>Anabas testudineus</i>	++	-	-	++
<i>Channa punctatus</i>	-	-	++	
<i>Aorichthys seenghala</i>	++	++	++	+
<i>Rita rita</i>	++	++	++	+

FISHERY RESOURCE ASSESSMENT

Assessment of inland resources using Remote Sensing Techniques

Water and soil characteristics were taken from fourteen selected water bodies during post-monsoon (13th Nov. 2007 to 23rd Nov 2007) and pre-monsoon (22nd May 2008 to 30th May 2008) from Purulia and Bankura districts in West Bengal. The samples were collected in the water bodies during the period of satellite pass on that path. The water quality parameters observed were Temperature, Transparency, Dissolved Oxygen, Sp. Conductivity, pH, Total Dissolved Solid, Total Alkalinity, Free CO₂, chlorinity, Salinity, NO₃, Total Nitrogen, PO₄, Sulphate, Silicate, hardness, Ca, Mg, Gross Primary Production, Net Primary Production and Respiration. Observations on soil characteristics were made on sand, silt, clay, pH, sp. conductivity, organic Carbon, total Nitrogen, available Phosphate, Free CaCO₃ and available-N.

Using image processing spectral reflectance of red, green, near infrared and infrared was calculated and degree of association with water quality parameter was measured. The various correlation are: Air Temp, Water temp is significant in 0.01 level in IR band and significant in 0.05 level in Red band. Chlorinity, Salinity is significant in 0.01 level in IR, Red and green band but association is so high in red band ($R^2=0.81$) No₃ is significant in 0.05 level in IR band. Total -N significant in Red and Green in 0.05 level. Sulphate is significant in red and NIR band in 0.01 level and 0.05 level in green band. Hardness and Ca is significant in 0.05 level in Red and NIR band respectively

DEM, catchment area and streams were delineated for the following four water bodies namely i) Hunumata Dam ii) Tilaitanr Bundh iii) Kumari Dam iv) Muruma Bundh. Land use map for four catchment area were also created using LISS III imageries using Nov 07 satellite imagery.

Images were also classified for two watersheds in bankura and Purulia district using image processing software to understand the features of watershed.

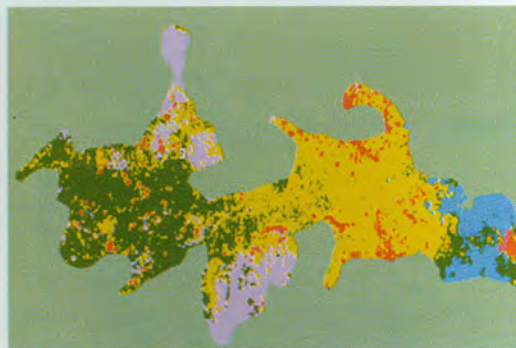
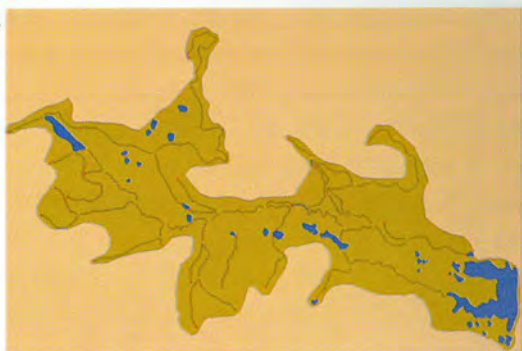


Mini watershed in Purulia (Murguma)

- ◆ Area of the watershed is 7525 ha
- ◆ Detail run off area first order, second order and third order streams of the water shed has been digitized
- ◆ Physical, chemical, and biological characteristics of individual stream based on their order
- ◆ Image classification shows 70% of area covered with forest and dense forest



Fig 18. Image classification of mini watershed in Purulia (Murugma)



Mini watershed in Bankura (Kanta bundh)

- Water shed area is 2924 ha and waterbody is 111.5 ha
- Run of area is combination of irrigated land and forest.

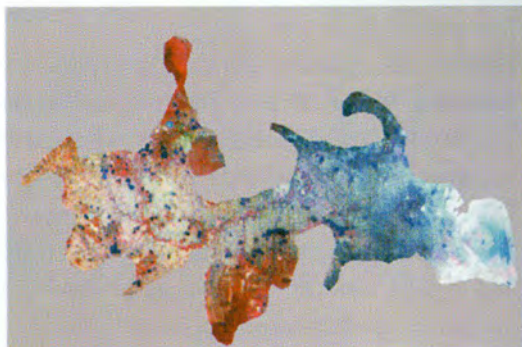


Fig 19. Image classification of mini watershed in Bankura (Kanta Bandh)

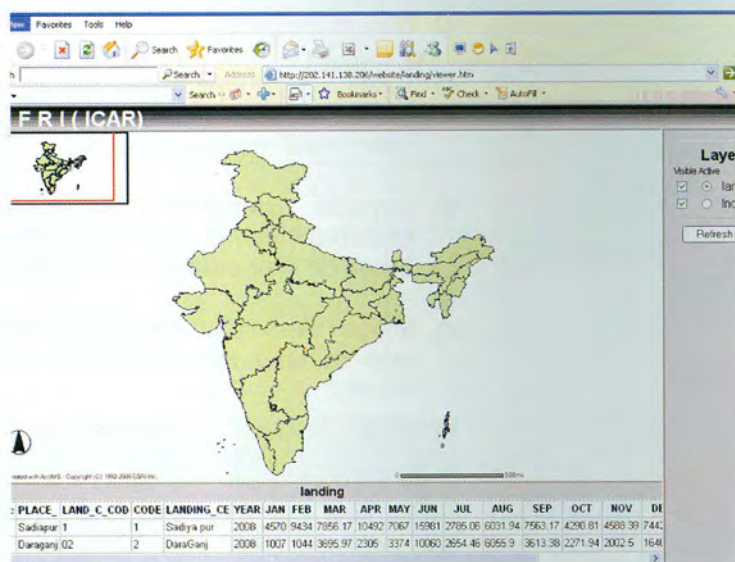


Fig 20. Web GIS showing landing information of rivers

Development and standardization of database on GIS platform for capture fisheries

The catch data at Allahabad and Guwahati centers of the Institute are being utilized for the development of database under the project. The data collected at different centers from various water bodies have been compiled and stored in the database for future use.

Brahmaputra River (Uzan Bazar)

Monthly data on fish catch are recorded by Guwahati centre

of CIFRI for Brahmaputra River at Uzan Bazar. The data indicates *A.morar*, *A.coila* and *T.ilisha* as the dominant species in the catch. The estimated total catch was worked out at 108.36 t during 2008. In previous year the catch was 259.56 t from the same landing Centre. The fish catch composition and monthly total catch is shown in Fig.21. It is observed that during monsoon and post monsoon period total catch drastically decrease in comparison to previous year.

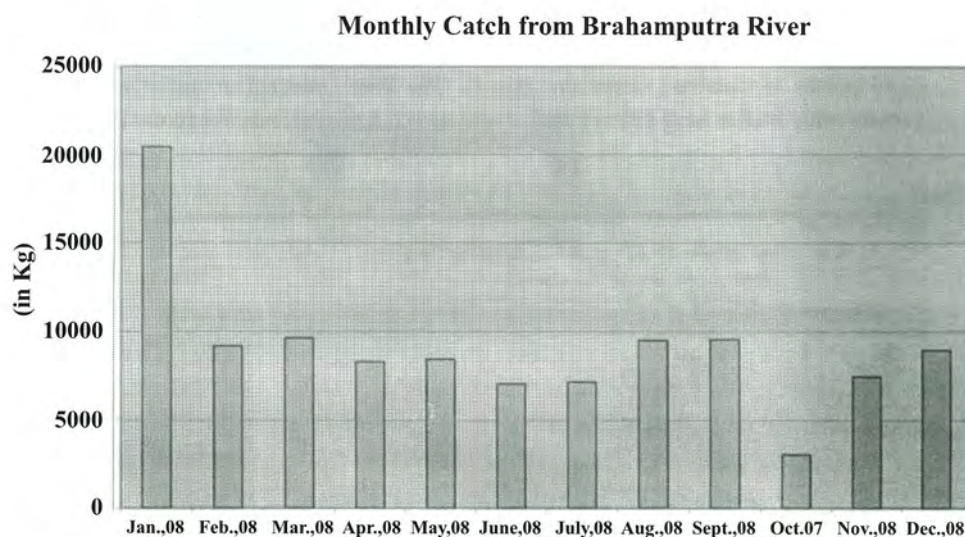


Fig. 21 Monthly total catch from Brahmaputra river

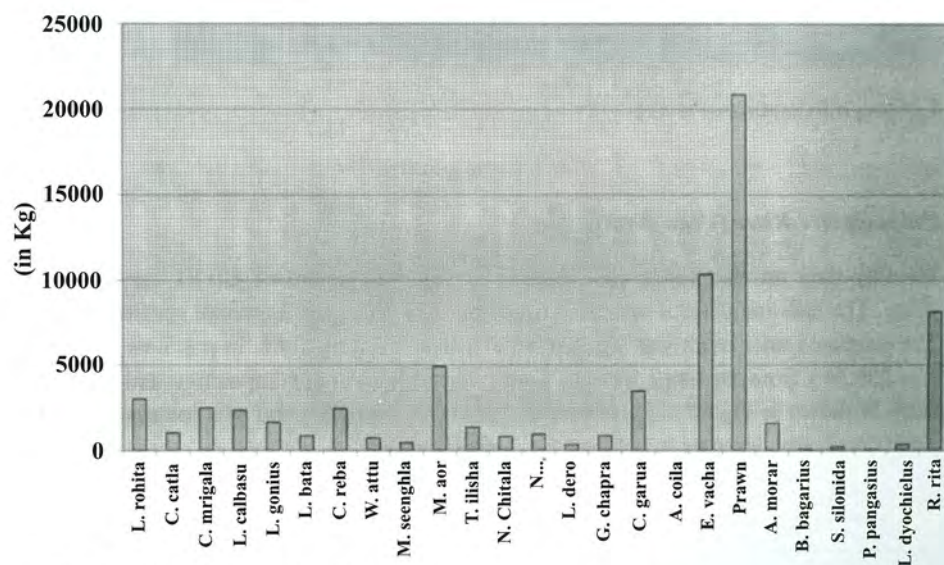


Fig. 22 Fish catch composition of Brahmaputra river



Ganga River (Allahabad)

The catch data are recorded from the Ganga river system at Allahabad centre. The total catch from Sadiapur has been worked out at 88.10 t and from Daragunj at 39.73 t. The contribution of tilapia has increased four-fold this year in comparison to previous year. In 2007 tilapia catch was 5606 kg that increased to 19272 kg at the cost of common carp, which decreased from 40127 to 22451 kg.

Development of Fish identification Software: Fish identification is complicated and it is certainly not very accurate to identify a fish simply by looking at a picture in a book. Identification of fishes is based mainly on external characters such as body shape, length, depth, mouth and nature of fish spines, scales etc. Taxonomic characters are often very subtle such as a slight difference in the number of scales in the lateral line or a couple of extra rays in the dorsal fin.

A software module has been developed using Visual Basic and Microsoft Access as back end to identify the order level, the species wise identification is under process. The developed computer program contains a logical series of steps to help identify a fish based on its characters using keys. The software contains images and sketches so that the program facilitates the users to identify the fishes interactively.

Fish based farming systems in seasonally flooded area through community participation

A trial was carried out in seasonally flooded area of the Block Moina, District Purba Medinipur of West Bengal. The area of the site was 33 ha where 20 land holdings were existing. The land holders cultivated summer paddy before monsoon in the site. During monsoon the total area became one sheet of water having average depth of 1.38 m. After accumulation of water, a duly constituted village committee took the possession of the water body and leased it out for fish cultivation. CIFRI through scientific intervention stocked the water body @ 6000 fingerlings of Indian Major Carps, size of which varied between 120 mm and 200 mm and obtained a production of 2524.6 kg/ha after 5 months of culture period. Miscellaneous wild fish contribution to the total production was 25.75%. Paddy production obtained from site was 3000 kg/ha in 90 days. Average water productivity achieved through this experimentation was 182.94 g/m³. The fund generated as lease value, the village committee spent the same for the benefit of the villagers.

Economic valuation of inland fisheries resources in India

The project study sites were Chandania, Floodplain Lake in 24 Parganas (North), West Bengal and Kangsabati Reservoir in Bankura district of West Bengal. The analysis of gathered data revealed following observations.

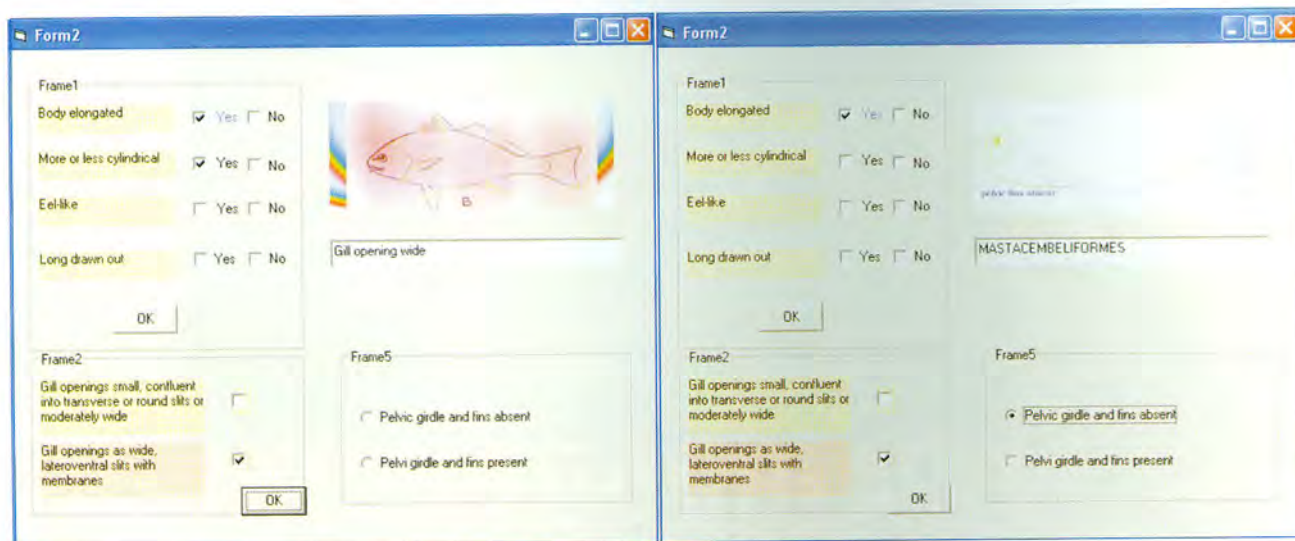


Fig. 23 Glimpse of fish identification software

Chandania beel

Socio-economic features of beel fishers: Socio-economic features of beel fishers indicated that over 90% fishers belonged to scheduled caste and remaining to scheduled tribe. Major occupation of the fishers was fisheries with agriculture and daily labour as the secondary source of income. Only 25% of fishers had their own non-mechanised wooden boat.

Institutional arrangements: The ownership of beel was with State Departments of Welfare, Revenue and for fisheries purpose it is with Department of Fisheries. The beel was adopted by co-operative, Jaleswar Matsyajivi Sehkari Samiti Limited, Shergarh for fisheries in 1957. Now the number of fishers is 2500 out of which active fishers are 650. The lease period is one year with lease amount of Rs 10195/- (Rs 206/ha). Society permanent members are 374 and fishing non-members are 246.

Livelihoods and community interaction in resources: Primarily fishers were dependent on fishing in the beel. The fishing may be for stocked fish or minnows. For commercial fishing of stocked fish, average number of fishers fishing per day was 250 and number of fishing days per fisher varied from 30 to 65. The fishing of Minnows was done round the year (320 days/year) and average CPUE for minnows was estimated at 1.75 kg.

There are 4156 number of households with total population at 16,627 around Chandania beel. The population composition indicated 70% farmers, 24% fishers, and remaining in service or business. Total area around the beel is about 84 Km², out of which agriculture land is 50 Km² and others including forests, pastures, and domestic lands is 34 Km². These form the major resources for the livelihood and the resources for community interaction/utilization besides the beel itself.

Various uses, goods and services: *Direct uses:* Fisheries; agriculture, Habitat for aquatic biomass; Recreation and tourism; Domestic uses; Bathing; Washing clothes; Tending cattle; Dumping of domestic waste, fuel wood, fodder,

Indirect uses: Nutrient cycling, pollution reduction, Natural habitat, biological/ecosystem support, Groundwater recharge, etc.

Non use: Biological conservation, habitats expending uses for aquatic biomass, aesthetics and cultural heritage.

Kangsabati reservoir

Kangsabati reservoir is located at Mukutmanipur, about 55 km away from Bankura. It is the second biggest earth dam of India with an average area of 3312 ha. It is fed by rivers Kangsabati, Kumari and Tatak. Its catchment area under Kangsanati river is 1024 km², while under Kumari basin at 1216 km². The command area of the reservoir is 5568 km².

Socio-economic and institutional features: The number of families per village varied from 40-45 with family size of 7-9 members. The reservoir has the ownership of Department of Irrigation and for fisheries purpose, the reservoir is managed by DoF.

The community interactions and uses: 127 villages are located on the banks of reservoir with 55 at Kumari and 72 at Kangsabati. The population living in these villages forms the main community users of the reservoir, besides the tourists regularly visiting the reservoir site.

The reservoir provides irrigation to agricultural land in 11 blocks of Bankura, 13 blocks of Medinipur and one block in Hoogly district. The net irrigated area is 3.4 lakh ha in Kharif and 0.61 lakh ha in Rabi. Kangsabati reservoir supplies water to Khatra sub division for domestic uses after necessary treatment. Bangopalpur Reserve Forest, a home of many species of flora and fauna and one deer park located at inside the reservoir made the reservoir a good tourism site for past few years.

Value estimates for goods and services provided by the reservoirs: The total goods and services provided by the reservoir were estimated at Rs 18.11 crores, with maximum share for Irrigation/ground water recharge (90%) followed by fish (5%), forest products (3%) and recreation and tourism, domestic water supply and conservation of habitat for aquatic biomass, aesthetics, etc. for the remaining share.



SPONSORED PROJECTS

Climate change

Out of the 14 major river systems studied in India, four rivers are predicted to lose more than 7% of fish species under climate warming scenario as determined from the model developed.

Carp reared at 34°C grew significantly faster (18.38 cg in a day) than those at 29°C, 30°C, 31°C, 32°C 33°C and 35°C. It would take average 54-55 days for a carp to double in weight at 30°C to 33°C and 35°C, but at 34 °C it would take only 35-36 days.

Apart from the other source and variables of vulnerability for district south 24 Parganas, W.B. five sources which are direct or indirectly related to the fisheries sector of South 24 Parganas expressed only 11.11% of total District's vulnerability. The fisheries sector contributing 26.54%, the occupational index contributing only 15% and the geographical location contributing 22.12% of the expressed vulnerability.

Water resources of south 24 Parganas district were delineated using IRS 1D PAN + LISSIII merged satellite data using supervised classification and visual interpretation. Most of the water bodies are below 10 ha. Digital Elevation Model was generated from SRTM (Shuttle Radar Topographical Mission) of 90m spatial resolution data. The extent of land that will be submerged under scenarios of sea water rise in Sagar island, Sunderbans was estimated.

Organic Farming

With a view to popularizing organic farming for sustainable aquaculture in the rural areas experimentations in some areas of West Bengal were carried out utilizing organic manures namely vermi-compost, cow dung, compost and duck droppings. The abiotic and biotic factors were observed to be conducive for favourable fish production. The productions obtained under carp culture utilizing duck droppings, compost, vermi-compost and raw cow dung were 2707 kg/ha/300 days, 2041 kg/ha/300 days, 1635 kg/ha/300 days and 2176 kg/ha/300 days respectively.

Tropical reservoirs productivity

The project was implemented in Indo-Gangetic Basin with case studies at Pahuj reservoir in Uttar Pradesh and Dahod Reservoir in Madhya Pradesh.

Cage culture experiments applying low cost technology were conducted in both the reservoirs to raise stocking materials to be stocked in those reservoirs. The cost of production of each fingerling is assessed at Rs. 0.40. Fish yield is more in Pahuj (123 kg/ha/y) than Dahod (55kg/ha/y). Fishing right is vested with DoF, M.P while it is given to lessee in case of Pahuj. Fish production is enhanced from 17.5 t to 22.06 t in Dahod while it is 26.06 t to 64.60 t in

Pahuj during 2006 to 2009 respectively. Thus, fishery was enhanced 26 % & 148 % in Dahod & Pahuj reservoir respectively due to project interventions.

Assessment of the socio-institutional environment: Socio-institutional environment of selected reservoirs was analyzed under different fishing regimes towards improving fish productivity and equity. The in-depth analysis and comparison of i) fisheries management by DoF and contractor, and ii) fishing by fishers under royalty and contractor regimes revealed the positive and negative implications. The fish yield in former regime was comparatively low but the environment favoured fishers for equity issues. It was vice-versa for the other environment. These implications are expected to lead towards framing policy guidelines and action points for reservoir fisheries development in the country, which may be used by DoFs of different states and other relevant institutions like NFDB, State Fisheries Federations, Ministry of Agriculture, Government of India, etc.

Self-finance system established at local/community level: The measures suggested to form saving/micro-finance units and promote small savings will help fishers, fisher co-operatives and DoFs in establishment of Self –finance system. Using the suggested measures, fishers, fisher co-operatives and DoFs established such a system at Dahod reservoir.

Exploring Market Opportunities for fisheries Sector in India

The responsibilities of CIFRI were to i) study marketing policies; ii) investigate structure, conduct and performance of the wholesale/retail fish markets; iii) study common market channels for selected inland fishes and work out their price spread and efficiency; and iv) document success stories. CIFRI implemented the project in the states of West Bengal and Tripura. The fish markets studied were Howrah, Sealdah, B. K. Paul and Malanch in West Bengal and Battala and Udaipur in Tripura. The success Stories of BENFISH in West Bengal was documented. There was no fish marketing policy in two states under study except one legislation of registering and monitoring the catch and performance of fish traders in West Bengal. Information was collected on the structure performance and prices of fish at various markets and existing fish marketing channels

The fish prices for most common fish species at Kolkata were Rs 76/kg for Indian major carps, Rs 159/kg for hilsa and Rs 123/kg for Mangur. The fish marketing efficiency was highest for Hilsa at 77% followed by Mangur at 71 % and IMC at 53% depending upon the marketing channels for their disposals. The suggestions for improvement in fish marketing, development of fish market infrastructure and

the investment needs were also given in the report for both the states.

Database and information networking for fisheries : The objectives of the scheme are mapping inland water bodies of India using remote sensing data, developing Geographical Information System (GIS), imparting training on sampling methodologies, and carrying out sample survey in inland fishery resources and their potential fish production. Mapping of water bodies of seven states was completed using 5.8 m resolution data. Based on sampling methodologies, Software was developed for catch estimation using visual Basic and MS Access. Training were imparted to the State fisheries officials how to use the software and the methodologies for estimation of fish catch. Water bodies (>0.5 ha) have been identified and mapped using LISS III (23.5) and PAN (5.8 m) imageries for two states namely, Tamil Nadu and Jharkhand. Ground truthing was done to make verification of water bodies identified by satellite data. This was carried out in the water bodies (>10 ha) in 20 districts of Punjab, Haryana and Tamil Nadu using GPS and preliminary base map of waterbodies. Training programmes were organized on "Sampling Methodologies for Estimation of Inland Fish Catch in India and Catch Assessment Software" for 36 officials of 19 states at four centers of CIFRI namely, Barrackpore, Allahabad, Guwahati, and Bangalore.

Nutrient Profiling and Evaluation of Fish as a Dietary Component: The outreach Activity on Nutrient Profiling of Fish is a new research initiative under the XI Plan which functions in Consortium mode involving seven research institutes under the Fisheries Division of ICAR. CIFRI is the Lead Institute and the Participating Institutes are CIFA, CIBA, CIFT, CMFRI, CIFE and DCFR. The two main objectives of the project are: 1) Nutrient profiling of fish with respect to such variables as species, size, seasons, habitats and production systems for promoting it as a health food; 2) Assessment and sample survey of fish consumption rate and pattern across the country and clinico-epidemiological studies on general health profile of population to correlate the fish intake and 'low birth weight' (LBW).

During the current year a Launch Workshop of the Project was successfully conducted on 31st July - 1st Aug 2008. For familiarizing the project partners for following uniform methodology for all analytical work, a 'Methodology Workshop' for the PIs and Co-PIs was organized at CIFT, Cochin on 17-22 Nov 2008.

Microbial phosphorus transformations in inland open waters: The AMAAS project was initiated in January 2009

with objectives of understanding microbial and chemical processes of P transformations and availability in inland open waters, and isolation of phosphorus releasing or polyphosphate accumulating bacteria for possible application in production enhancement or pollution bioremediation in aquatic environments. The project work has been initiated on these lines.

Arsenic in food chain: cause, effect and mitigation:

Baseline survey was continued in an arsenic contaminated village in Nadia and an uncontaminated village in Hooghly district of West Bengal covering fishery resources, fish production, fish consumption, etc. Detailed studies on the arsenic content in water, sediment and fishes of the inland water bodies of the arsenic contaminated villages revealed quite high level of the metalloid especially in sediments in water bodies receiving arsenic contaminated ground water. On an average, 20% of the fish flesh samples were found to retain arsenic above the permissible level of 100 µg kg⁻¹. Arsenic accumulation was found in the sequence: *Catla catla* > *Labeo rohita* > *Cirrhinus mrigala*. Indian major carps flesh samples from non-contaminated area and those transported from South-Indian states were free from arsenic. To study the microbial arsenic transformations, 50 presumptive arsenic reducing and 43 arsenic oxidizing bacteria were isolated from water, soil and cattle faeces. The oxygen requirement of the isolates in fluid thioglycolate medium indicated their aerobic or microaerophilic nature. Electrophoretic analyses of tissue proteins from Arsenic-affected areas vs. cohort controls detected expression of HSP70 in foot tissues of gastropods and p53 protein in muscle tissues of *L. rohita* by Western-blot analysis. Clinically important parameters viz. total protein, albumin, globulin, urea, uric acid, bilirubin, cholesterol, triglycerides were analyzed in fishes to look for Arsenic-related biochemical changes. Pathologically, kidney of *C. mrigala* from arsenic contaminated area exhibited profuse swelling and focal granulomass of the collecting tubule.

Toll-like Receptors in Phylogenetically Divergent Fish Species - Their Contribution in Modulating the Innate Immunity:

The project objectives are (a) To study variation in TLR gene expression induced by three types of pathogens / ligands in phylogenetically divergent fishes viz. carp, catfish and shark, (b) Assessing the divergence of key TLR genes playing a role in the innate immunity of fishes, (c) To understand the contribution of TLR signalling pathway(s) in the innate immunity of fishes & (d) strategic delivery of TLR - ligands and testing their efficacy to modulate innate immunity *in-vivo*. The consortium institutes/partners are CIFA, Bhubaneswar (CCI), CIFRI, Barrackpore, Kolkata (CCPI) and TANUVAS, Chennai (CCPI). The project duration was January 2009 to March 2012. Project research work has been initiated.



Sustainable Livelihood Improvement through Need Based Integrated farming System Models in Disadvantaged Districts of Bihar:

One eco-hatchery for carp breeding was procured and installed at the project site. Thirty six cages were fabricated using HDPE nets and relevant accessories for pen construction were purchased and 6 numbers of pen using exclusively HDPE net were fabricated and installed. Work at the cluster site commenced with the selection of cluster/village/ farm families. So far, baseline survey of 92

families living around the selected cluster site was completed. Under fisheries management of open water, experimental fishing was carried out to understand the existing fish fauna and their community structure. The natural fisheries dominated by catfishes (32% , *Wallago attu*, *Mystus seenghala*, and *Clarias batrachus*), murrels (24%, *Chana punctatus*, *C. striatus*), minnows (19%, 7 species of *Puntius*), major carps (13%) and other miscellaneous fishes (12%).

MANPOWER SUPPORT TO ONGOING PROJECTS FOR THE YEAR 2008-09

Programme	Project	Personnels
Riverine Fisheries RFM/NR/07/01/000 Developing conservation and fish stock management protocols for the rivers and associated ecosystems	RFM/NR/07/01/001 Generating benchmark information on ecology and fisheries of the Yamuna river system for formulation of management action plans	Scientific Dr. H. P. Singh, Dr. D. Kumar, Dr. R. N. Seth, Dr. R. K. Tyagi, Dr. V. Pathak, Dr. B.K. Singh, Dr. R. S. Srivastava, Dr. K. D. Joshi, Technical Shri S.K. Srivastava, Dr. K. Srivastava, Shri J.P. Mishra
	RFM/NR/07/01/002 Understanding the impact of river linking project on the ecology and production functions.	Scientific Dr. H.P. Singh, Dr R.K. Tyagi, Dr V. Pathak, Dr. R.S. Srivastava, Dr K.D. Joshi Technical Shri S.K. Srivastava, Dr. K. Srivastava, Shri J.P. Mishra
	RFM/NR/07/01/003 Environmental flow requirements of various categories of rivers in India.	Scientific Dr. V. Pathak, Dr. R. K. Tyagi, Dr. K. D. Joshi Technical Shri S.K. Srivastava, Dr. K. Srivastava, Shri J.P. Mishra
	RFM/NR/07/01/004 Assessing the feasibility of increasing water productivity in canal command areas through fishery intervention.	Kept in abeyance due to closure of centre.
Estuarine Fisheries ESF/ER/07/02/000 Development of sustainable fisheries management protocols for estuaries and associated waterbodies	ESF/ER/07/02/001 Generating benchmark information/data on ecology and fisheries from east-coast estuarine systems (Godavari/Subarnrekha)	Scientific Dr. Amitabha Ghosh, Dr. K.R. Naskar, Dr. B.C. Jha, Dr. B.B. Satpathy Technical Dr. A.K. Chattopadhyay, Shri T. Chatterjee, Ms. K. Jacqueline, Shri D. Sanfui, Ms. A. Sengupta, Shri D. Saha, Shri A.K. Barui, Shri A. Roychowdhury, Shri S. Mondal, Shri A. Jana
	ESF/ER/07/02/002 Generating information on the migratory pattern, behaviour and other relevant data for designing fish passes/hydraulic structures for Hilsa and other species for their migration.	Scientific Dr. N. P. Srivastava, Dr. B.B. Satpathy, Dr. Amitabha Ghosh, Dr. B.C. Jha, Technical Shri C.N. Mukherjee, Shri R.C. Mandi, Shri T. Chatterjee, Ms. K. Jacqueline, Shri D. Sanfui, Ms. A. Sengupta, Shri K.P. Singh, Shri B.N. Das, Shri D. Saha, Shri A.K. Barui, Shri A. Roychowdhury, Shri C.P. Singh, Shri A. Jana

	ESF/ER/07/02/ 003 Ecology, bio-diversity and fisheries of a brackishwater lagoon- Pilicat	Scientific Dr. B.C. Jha, Dr. D. Nath, Shri N.P. Shrivastava, Technical Shri R.C. Mandi, Shri D. Sanfui, Ms. A. Sengupta, Shri B.N. Das, Shri A. Roychowdhury, Shri S. Mandal
	ESF/WR/07/02/ 004 Developing and testing software based model as a forecasting mechanism for west-coast estuarine ecosystem.	Scientific Dr. S. N. Singh, Dr. K. Chandra, & Ashish K. Prusty Technical Shri R.C. Mandi, Shri R.K. Sah, Shri T.K. Haldar, Ms. K. Jacqueline, Shri B.N. Das, Shri K.P. Singh, Shri A. Roychowdhury
Reservoir Fisheries RES/SR/07/03/000 Improving the fish productivity of Indian reservoirs	RES/SR/07/03/001 Multi-location trials on improving fish yield in small reservoirs located in different agro-climatic zones (Karnataka and Kerala)	Scientific Dr. D. S. Krishna Rao Shri M. Karthikeyan & Dr.(Smt.) Rani Palaniswamy Technical Shri Sadhukhan, Smt. Usha Unnithan, Shri M.E. Vijay Kumar
	RES/SR/07/03/002 Characterization of fishery and population trends using acoustics and experimental fishing	Scientific Shri M. Feroz Khan, Dr. Preetha Panikkar Technical Shri M.E. Vijay Kumar
	RES/SR/07/03/003 Development of models for fish yield estimation in reservoirs	Scientific Shri M. Karthikeyan Dr. D. S. Krishna Rao
	RES/SR/07/03/004 Enhancement of Fish production in a small reservoir of Uttar Pradesh	Scientific Dr. R. N. Seth, Dr. B. K. Singh , Dr. P. K. Katiha Technical Shri S. Shrivastava, Dr. K. Shrivastava
Wetlands Fisheries WLF/ER/07/04/000 Developing fishery management norms for sustainable fisheries in floodplain wetlands	WLF/ER/07/04/001 Testing and refinement of fish yield enhancement strategies in floodplain wetlands.	Scientific Dr. M. A. Hassan, Dr. A. Mukherjee, Smt. G.K. Vinci, Dr. S.R. Das, Dr. A. K. Das, Shri. A. Hajra Technical Dr. B.K. Biswas, Shri D.K. Biswas, Shri S. Ghosh, Ms. Subhra Saha, Shri S. Das, Shri B. Naskar, Shri Y. Ali
	WLF/ER/07/04/002 Fish stock assessment in wetlands and application of population and biomass models for sustainable fishery management	Scientific Dr. V.R. Suresh, Smt. G.K. Vinci, Dr. A. Mukherjee, Dr. A. K. Das, Shri S.K. Sahu Technical Shri D.K. Biswas, Ms. Subhra Saha, Shri S. Ghosh, Shri B. Naskar, Shri Y. Ali



	WLF/ER/07/04/003 Developing site specific fish based farming system in seasonally flooded area through community participation.	Scientific Dr. Utpal Bhaumik, Dr. P.K. Katiha, Dr. Ganesh Chandra, Dr. D. Debnath Technical Shri K.K. Sharma, Shri Sukumar Saha, Shri A. Mitra
	WLF/NR/07/04/004 Fish yield enhancement approaches in U.P. wetlands	Scientific Dr. Dharendra Kumar, Dr. K.D. Joshi, Dr. B.K. Singh, Dr. R.S. Shrivastava Technical Shri S. Shrivastava, Dr. K. Shrivastava, Shri J.P. Mishra
	WLF/NE/07/04/005 Standardizing fish stock management and enhancement protocols	Scientific Dr. B.K. Bhattacharjya, Ms. Sona Yengkokpam. Technical Dr. A. Biswas, Shri K.K. Sharma, Shri P. Gogoi
	WLF/NE/07/04/006 Evaluation of health and biodiversity implications of different enhancement regimes.	Scientific Dr. Md. Aftabuddin, Dr. V. Kolekar, Dr. R.K. Manna Technical Shri P. Gogoi
	WLF/NE/07/04/007 Socio-economic evaluation and delivery mechanism in floodplain fisheries	Scientific Dr. Ganesh Chandra Technical Shri K.K. Sharma, Shri P. Gogoi
Research Programmes of North East FOR/NE/07/05/000 Pilot scale validation/ demonstration of fishery management packages, resources estimates & biodiversity estimation in north-eastern region in linkage with different stakeholders	FOR/NE/07/05/001 Fishery resource assessment through GIS application	Scientific Dr. R.K. Manna, Md. Aftabuddin Technical Shri P. Gogoi
	FOR/NE/07/05/002 Fish diversity and catch estimates of river and wetlands	Scientific Dr. B.K. Bhattacharjya Technical Dr. A. Biswas, Shri P. Gogoi
	FOR/NE/07/05/003 Demonstrations of enclosure culture technology in beels	Scientific Dr. B.K. Bhattacharjya, Dr. V. Kolekar, Ms. Sona Yengkokpam Technical Shri K.K. Sharma, Shri P. Gogoi
	FOR/NE/07/05/004 Extension out-reach, service delivery and HRD activities	Scientific Dr. Ganesh Chandra, Dr. V. Kolekar, Dr. B.K. Bhattacharjya, Dr. R. K. Manna, Dr. Md. Aftabuddin, Ms. Sona Yengkokpam Technical Dr. A. Biswas, Shri K.K. Sharma, Shri P. Gogoi

Environment And Fish Health Management FHE/ER/07/06/00 Environment and Fish Health Management in Inland Open Waters	FHE/ER/07/06/001 Developing fish-based indicator tools for environment monitoring	<i>Scientific</i> Dr. M.K. Das, Dr. P.K. Saha, Dr. M.K. Bandopadhyay, Dr. S.S. Mishra, Dr. S. Samanta, Dr. B.P. Mohanty, Dr. S.K. Manna, Shri P. Maurye, Shri M.P. Brahmane <i>Technical</i> Dr. S. Bhowmik, Shri L. Mahavar, Ms. Keya Saha, Shri, H.K. Banik, Shri S.K. Pal, Dr. Ranjana Sinha, Shri S. Banerjee, Shri A. Ghosh
	FHE/ER/07/06/002 Metal and Pesticide monitoring and its bio-magnifications in stressed aquatic environment	<i>Scientific</i> Dr. S. Samanta, Dr. P. K. Saha <i>Technical</i> Ms. Keya Saha, Shri L. Mahavar, Shri S. Banerjee, Shri A. Ghosh
	FHE/ER/07/06/003 Microbial diversity assessment and their role in environmental mitigation in inland waters	<i>Scientific</i> Dr. S.S. Mishra, Dr. S. Samanta, Dr. S.K. Manna, Shri P. Maurye, Shri M.P. Brahmane <i>Technical</i> Dr. S. Bhowmik, Shri L. Mahavar, Shri, H.K. Banik, Shri Sk. Rabiul
	FHE/ER/07/06/004 Estimation of stress mediated genetic contamination in fishes from different stressed ecosystems	<i>Scientific</i> Shri M.P. Brahmane, Shri P. Maurye, Dr. S. K. Manna <i>Technical</i> Shri Sk. Rabiul, Shri S. Banerjee
	FHE/ER/07/06/005 Developing health management protocols for inland ecosystems through Proteomics	<i>Scientific</i> Dr. B.P. Mohanty, Shri D. Karunakaran, Dr. M.K. Bandopadhyay, Shri P. Maurye <i>Technical</i> Dr. S. Bhowmik, Shri Sk. Rabiul
Fisheries Resource Assessment FRA/ER/07/07/000 Assessment of resources and database development in GIS platform for Inland Fisheries using Remote Sensing Techniques	FRA/ER/07/07/001 Assessment of inland resources using remote sensing techniques	<i>Scientific</i> Shri D. Karunakaran, Shri S.K. Sahu, Dr. D. Nath <i>Technical</i> Ms. Sucheta Majumder, Shri S. Mandal
	FRA/ER/07/07/002 Development and standardization of database on Web GIS platform for capture fisheries	<i>Scientific</i> Shri S.K. Sahu, Shri D. Karunakaran <i>Technical</i> Ms. Sucheta Majumder
Fisheries Economics FSE/ER/07/08/000 Economic valuation of inland Fisheries Resources in India	FSE/ER/07/08/000 Economic valuation of Inland Fisheries Resources in India	<i>Scientific</i> Dr. P.K. Katiha, Dr. R.S. Srivastava <i>Technical</i> Shri D.K. Biswas, Shri B.N. Das, Shri D. Saha, Shri S. Ghosh



TECHNOLOGY ASSESSED AND TRANSFERRED

Mass Awareness Programmes

Programme	Date	Participants	Venue
Fish and prawn seed conservation	05.04.08	605 fishers	N a b d w i p a n d Krishnanagar, Nadia, West Bengal
	16.05.08		
	09.07.08		Sagar Island, South 24 Parganas, West Bengal
	01.08.08		
	01.07.08		Diamond Harbour, South 24 Parganas, West Bengal
	22.08.08		Frazergunj, West Bengal
	20.11.08		Frazergunj, West Bengal
Eco-friendly management of reservoirs	25.2.09	Officers of Dept. of Fisheries, Karnataka, fishers and NGOs	Maithon, Jharkhand Dhulian, Near Farakka, West Bengal
			Suvarnavathy reservoir, Karnataka



Training and Mass Awareness Programmes in Progress

Trainings

Training Programme	Participants	Date	Venue
Short-term training for administrative, financial matters, by NAARM, Hyderabad	Administrative , Accounts, Audit, and scientific staff of CIFRI	April 25-30, 2008	CIFRI, Barrackpore
10 day training program on Inland Fisheries	40 fish farmers from Patna district, Bihar	May 5-16, 2008	CIFRI, Barrackpore
Survey methodology for collection of statistical data and estimation of inland fish catch and IFMS software	State fisheries officials of Assam, Mizoram, Nagaland, Manipur and Arunachal Pradesh states	June 19 - 21, 2008	CIFRI, Barrackpore
Survey methodology for collection of statistical data and estimation of inland fish catch and IFMS software	State fisheries officials of Assam, Mizoram, Nagaland, Manipur and Arunachal Pradesh states	June 25-26, 2008	CIFRI, Barrackpore
Recent advances and technologies for Fisheries development in Northeastern India	Twenty six subject matter specialists of Krishi Vigyan Kendras of Northeastern region	July 4-6, 2008	Regional Centre of CIFRI, Guwahati
Catch Assessment Survey (IFMS) Software	Ten officers from Karnataka, Tamil Nadu, Kerala, Andhra Pradesh, and Pondicherry	July 3-4, 2008 & and July 7-8, 2008	Bangalore Centre of CIFRI
Survey methodology for collection of statistical data and estimation of inland fish catch and IFMS software	State fisheries officials of Tripura, Orissa, Sikkim, Meghalaya and West Bengal state	9 th July. to 11 th July, 2008	CIFRI, Barrackpore
Bundh breeding	Thirty five fish farmers	July 26-27, 2008	Ramsagar, Bankura
Reservoir Fisheries Management	Four M.F.Sc. students of CIFE	August 4-23, 2008	CIFRI, Barrackpore
Accessing consortium for e-resources in Agriculture a gate way of accessing e-journals	Scientist and Technical Officers of CIFRI	September 30, 2008	CIFRI, Barrackpore
Inland Fisheries Development	Thirty one Fisherwomen of Bihar	October 16-25, 2008	CIFRI, Barrackpore
Reservoir Fisheries Management	Thirty Fishermen of Orissa	December 1-10, 2008	CIFRI, Barrackpore
Inland Fisheries Development	Thirty Fishers of Bihar	December 15-24, 2008	CIFRI, Barrackpore

Exhibitions

Institute participated in the following exhibitions:

- “National level Science & Technology Fair, 2008” at Salt Lake City, Kolkata., during April 12 – 20, 2008. Thousands of people visited the stall.
- Silver Jubilee of NBFGR at Lucknow, Uttar Pradesh during April 26–27, 2008.
- CIFA , Bhubaneswar, Orissa during June 7 – 8, 2008.
- Second Green Revolution Summit and Expo 2008 at Science City, Kolkata during Sept 24-26, 2008,
- 32nd Conference of Ethological Society and National Symposium on Fish Behaviour during October 16-17, 2008
- 8th Indian Fisheries Forum during November 22-26, 2008 at Eastern Zonal Cultural Centre, Kolkata
- Krishi -o- Slipa Mela, Jagaddal, North 24 Parganas during December 27-02, 2008.



His Excellency, Governor of West Bengal Shri Gopal Krishna Gandhi visits CIFRI exhibition stall.

LINKAGES AND COLLABORATIONS

Linkage and collaboration in India and abroad including externally funded projects:

- Linkages have been made with National Remote Sensing Agency, Hyderabad to procure satellite maps. The help of Survey of India, Kolkata and NATMO, Salt Lake, Kolkata has been taken for using their wetland and other maps. Survey of India, Dehradun, was contacted to procure digital data on village boundaries and block boundaries maps.
- Linkage has been established with Central Pollution Control Board through a collaborative project entitled 'Assessment of fisheries with regard to water quality in the river Ganga and Yamuna'.
- The Vadodara Centre of CIFRI has developed linkages with Sardar Sarovar Narmada Nigam Limited, Gandhinagar, Department of Fisheries, Govt. of Gujrat; Gujrat Ecological Society, Vadodara and Department of Zoology, M.S.University of Borada on programmes of mutual interest.



CIFRI Scientist being honoured with Young Scientist Award in 8th IFF

AWARDS AND RECOGNITIONS

Person	Recognition
Sona Yengkokpam	Ph.D. degree in Fish Nutrition and Biochemistry from CIFE, Mumbai on 18 th November 2008.
Sona Yengkokpam	'AFSIB Young Scientist Award 2008' at the Eight Indian Fisheries Forum held on November 22-26 at Kolkata
Dipesh Debnath	“Young Scientist Award 2008” from Asian Fisheries Society of India, Indian Branch, at 8 th Indian Fisheries Forum held during November 22-26, 2008 at Kolkata

PUBLICATIONS

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- Suresh, R.; Ravisankar, T.; Ravindranath, K. and Mukta Menon, 2008. Domestic fish marketing in India – Changing structure, Conduct, Performance and Policies. *Journal of the Agricultural Economics Research Review* 21, Conference Number, 345-354.
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- Manna, R.K. and Sarkar, A., 2008. Seasonal variation of selected physico-chemical parameters of River Brahmaputra at Guwahati. *Journal of the Inland Fisheries Society of India* 40 (Special Issue): 99-108.
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CIFRI – Ek Anant Yatra

Uplabd Sevayen

Uttar Pradesh ki Jheel Paristhithiki avam Matsyaki

CONSULTANCIES

Title	Sponsoring Organisation	Budget (Rs. in Lakh)
Downstream plan for fisheries development in the downstream of Sardar Sarovar Reservoir	Govt. of Maharastra	38.58
Study of migration of fishes in river Subansiri and creation of hatcheries	NHPC, Assam	17.90



MEETINGS ORGANIZED

Joint Staff Council

Two meetings of IJSC were held on 20.6.08 and 13.3.09. The IJSC was reconstituted on 29.8.08 for a period of 3 years. The committee discussed various issues related to administration and finance. The committee made suitable recommendations, most of which have been implemented.

Institute Research Committee

The Annual Institute Research Committee Meeting was held at Barrackpore during 21-23rd April 2008 under the Chairmanship of Dr. K.K. Vass, Director, CIFRI. The meeting was attended by all scientists at Head quarters besides scientists from outstations. In accordance with the suggestions of RAC held on April 23-24, 2007, the work programme for 2007-08 was submitted by different Divisions at Head Quarters and Regional Centres. Progress of on-going Projects during 2007-08 were discussed. The proposed programmes for the year 2008-09 were discussed at length and the IRC approved 13 main themes for formulation of the Projects. The issues related to administrative and financial matters were also discussed in the meeting.

Research Advisory Committee

The Research Advisory Committee meetings were held during 2-3 May, 2008 and 6 February, 2009 at Central Inland Fisheries Research Institute, Barrackpore. Dr. M.V. Gupta, Ex-ADG, ICLARM World Fish, chaired the meetings. The other members of this committee are Dr. C.S. Singh, Retd. Dean, Fisheries; Dr. R.K. Sinha, Professor, Zoology, Dept. of Zoology, Patna University; Dr. U.C. Goswami, Professor,

Department of Zoology, Guwahati University and Dr. S. Kaul, Director, Ministry of Environment, Govt. of India. The meetings were attended by Heads of Divisions viz. Riverine, Estuarine, Reservoir, Floodplain Wetlands, Fish Health & Environment, Fishery Resource Assessment and HRD & TOT of CIFRI along with the scientists posted at Barrackpore and at outstations. All Heads of Divisions and other Principal Scientists presented the progress report of their respective divisions on various research projects. In the two meetings the progress reports of the various projects during the years 2007-08 and 2008-09 were discussed in depth. The committee gave valuable suggestions and direction. The meetings ended with the formulation of new project activities for the respective years with the approval of RAC.

Institute Management Committee

The 36th and 37th Meeting of the Institute Management Committee of the CIFRI were held at Barrackpore on 30th July 2008 and 21st February 2009 respectively. The meeting was chaired by Dr. K.K. Vass, Director, Dr. V.V. Sugunan, Assistant Director General (I.Fy.), ICAR, Shri R.N. Chowdhury, Director of Fisheries, Patna, Mr. Ejaz Ahmed, Patna (Nonofficial Member), Dr. M.M. Prasad, Pr. Scientist, CIFT and Shri U.C. Prasad, Sr. Administrative Officer, CIFRI attended the meeting. The Chairman briefed the members regarding the achievements made by the Institute under different Research Projects. The Committee discussed the agenda items for different administrative and financial items. Progress of civil works since last meeting was also reviewed.



IRC meeting in progress



Research Advisory Committee meeting



XIX Meeting of ICAR Regional Committee-II

CIFRI, Barrackpore, organized the XIX meeting of ICAR Regional Committee-II during September 26-27, 2008 at Orissa University of Agriculture and Technology, Bhubaneswar. *His Excellency*, the Governor of Orissa Shri Murlidhar S. Bhandare inaugurated the meeting. The meeting was chaired by Dr. Mangala Rai, Secretary DARE, Govt. of India and Director General, ICAR. A large contingent of members, more than 125, comprised the following delegates:

- Hon'ble Ministers from Orissa and West Bengal
- Secretary, DARE & Director General, ICAR
- Additional Secretary, DARE & Secretary, ICAR
- Members of the ICAR Governing Body
- Secretary Agriculture, Govt. of Orissa
- Special Secretary Fisheries, Govt. of West Bengal
- Adviser (Agri.), Planning Commission
- Six Vice Chancellors of OUAT, BCKV, WBUAFS, ANGRAU, and the faculty members of SAUs in the region
- Five DDGs & four ADGs from ICAR
- Directors of ICAR Institutes in the region
- Directors of NBPGR & IGFRI as special invitees
- Senior officers from the Ministry of agriculture, Govt. of India
- State Directors of Agriculture, Horticulture, Animal Husbandry & Fisheries, Govt. of Andhra, Orissa & West Bengal
- Regional Heads & Officer-in-Charge from the regional stations/centers of ICAR
- Representative of NABARD and other Scientists

A number of emerging issues related to agriculture and allied sectors were discussed in three technical sessions.

Fish Marketing Strategy

A meeting of NCAP-NFDB Sponsored project on "Exploring market opportunities for fisheries sector in India" was held at Institute's Headquarters on 24.10.08. A good number of representatives from the Fishing, Farming and Trading communities were present to discuss the project initiative *per se*, and the problems and prospects of the sector to facilitate developing market infrastructure for fisheries products.



Technical Monitoring Committee

Technical Monitoring Committee meeting of Central Sector Scheme was held on 12th February, 2009 under the Chairmanship of Dr. V.K. Bhatia., Director, IASRI. The other delegates of the meeting were. Dr. R.M. Dwivedi, Head SAC, Dr.P.Pandian (Dy.Advisor Fy. Planning Commission) and other officials from different states. All the Heads of Divisions and scientists posted at CIFRI, Barrackpore attended the meeting.



TMC meeting of Central Sector Scheme



Review meeting of outreach activities

Review Meeting of the Outreach Activities

The Annual Review Meeting of the Outreach Activities on 'Fish Feeds, Fish Genetic Stock and Fish Nutrient Profiling' was organised during 26-27th February, 2009 at CIFRI Barrackpore. Dr. S. Ayyappan, DDG (Fy.), ICAR chaired the meeting.

PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORKSHOPS, SYMPOSIA

Conference/Seminar/Symposium

Dr. Utpal Bhaumik participated in a 8-day Seminar on

"National Science & Technology Fair, 2008" held at Salt Lake City, Kolkata, during April 12 to 20, 2008.

Conference on 'Agricultural Development in NEH Region: Opportunities and challenges' organized by ICAR Research Complex for NEH Region, Umiam on 8th June 2008 (Participated by B. K. Bhattacharjya).

Seminar organized by the Indian Chamber of Commerce in connection with the Second Green Revolution Summit and Expo 2008 held at Science City, Kolkata during September 24 to 26, 2008 (Utpal Bhaumik).

32nd Conference of the Ethological Society of Indian and national Symposium on Fish Behaviour at CIFE, Mumbai during October 16-17, 2008 (Dipesh Debnath).

International Conference on 'Emerging Trends in Biological Sciences' organized by School of Biotechnology, KIIT University, Bhubaneswar on 24-25 Oct 2008. (B. P. Mohanty)

National Seminar on 'Wetland and Livelihood' at Jawaharlal

Nehru College, Boko, Kamrup, Assam, October 24-25, 2008. V. Kolekar, R. K. Manna and Md. Aftabuddin).

Second International Forum on Water and Food at Addis Ababa on November 10-14, 2008 organised by Challenge Program on Water and Food, IWMI, Colombo. (K. K. Vass, P.K. Katiha, N. P. Shrivastava, and A. K. Das)

The 8th Indian Fisheries Forum, Kolkata during 22-26 November 2008. Many scientists participated and presented their papers. (D.S. Krishna Rao, M. Karthikeyan, H.P. Singh, V. Pathak, R.N. Seth, P.K. Katiha, V. Pathak, B.K. Singh, K.D. Joshi, B.K. Singh, Kalpana Srivastava, Aftabuddin, M., P.K. Saha, M.A. Hassan, R.K. Manna, A.K. Das, D. N. Singh, Yengkokpam, S., D. Debnath, S. N. Singh, A.K. Prusty, M. Feroz Khan, S.K. Sahu, D. Karunakaran, D. Das, Utpal Bhaumik, V.R. Suresh, G.K. Vinci, A. Mukherjee, S.K. Sahu, M.K. Bandyopadhyay, M.K. Das, S.K. Manna, S. Samanta, S.S. Mishra, and B.P. Mohanty, D. Nath and others).

Seminar organized by the Institute of Engineers at West Bengal State Centre, Kolkata during December 19-20, 2008 (Utpal Bhaumik and Dipesh Debnath)

19th All India Congress of Zoology, National seminar on 'Biodiversity and Human Welfare'. December 29-31, 2008, Gauhati University, Assam. (V. Kolekar, B. K. Bhattacharjya, R. K. Manna, Md. Aftabuddin, Ganesh Chandra, K. K. Sarma and P. Gogoi).

96th Indian Science congress on 'Science, Education and attraction of talents for Excellence in Research', North Eastern Hill University, Shillong, Meghalaya, Jan 3-7, 2009. (K.K. Vass, S.S. Mishra, B.P. Mohanty, M.P. Brahmane, B.K. Bhattacharjya, G. Chandra).

Seminar on 'Productivity enhancement of beel fisheries of Assam' organized by Assam Fisheries Development Corporation, Guwahati in connection with Assam Matsya Mahotsav, 2009 on 30.01.09 (B. K. Bhattacharjya).

4th World Congress on Conservation Agriculture on 'Innovations for improving Efficiency, Equity and Environment' organized jointly by FAO, ICAR, NAAS, IFAD, RWC, ICARDA, ISSS & ISAE and held at New Delhi, India during February 4-7, 2009 (Ganesh Chandra). Seminar on "INDAQUA 2009", at Science City organized by MPEDA, during February 18 to 20, 2009 (Utpal Bhaumik).

2-day Seminar on Bengal Science Congress at Burdwan University during February 28 to March 1, 2009. (Utpal Bhaumik)

Workshops

State level Workshop on 'Insurance in Fisheries Sector' organized by Department of Fisheries, Govt. of Assam on 26th June 2008 at NIRD regional Centre, Guwahati (V. Kolekar & Ganesh Chandra).

Launching workshop of Outreach Activity on 'Nutrient profiling and evaluation of fish as dietary component' organized by and held at Central Inland Fisheries Research Institute, Barrackpore during 31st July and 1st August, 2008 (B.P. Mohanty, Md. Aftabuddin).

Workshop on MGLP modeling under Network project on "Impact Adaption and Vulnerability of Indian Agriculture to Climate change" at CARDS, TNAU, Coimbatore from 18-20, September 2008 (S.K. Sahu)

Inception Workshop on 'ITK in Fisheries Sector' organized by Central Institute of Fisheries Education held at CIFRI Regional Centre, Guwahati during 19-20 September 2008. (B. K. Bhattacharjya, G. Chandra, Sona Yengkokpam and P. Gogoi).

ICAR Training-cum-Workshop on "Intellectual Property and Technology Management" National Institute for Research on Jute & Allied Fibres Technology (NIRJAFT), Kolkata, 16-18 October, 2008 (G. Chandra).

Exploration-cum-awareness programme on Aquatic biodiversity conservation for fishers and fisheries officials, organized by NBFGR, Lucknow at CIFRI Regional Centre, Guwahati on 30.12.09 (B. K. Bhattacharjya, Ganesh Chandra, K.K. Sarma and P. Gogoi).

Workshop on "Sustainable Livelihood development through Fisheries and Aquaculture in NE region of India" jointly organized by Indian fisheries Association, Mumbai, CIFE, Mumbai, ICARRCNEH, Barapani, NBFGR, Lucknow, and DFR, Bhimtal at ICAR RC for NEH region, Barapani on 2nd January 2009 (G. Chandra).

Assam Matsya Mahotsav organized by Dept. of Fisheries, Govt. of Assam on 28th to 30th January 2009 at Guwahati. (B.K. Bhattacharjya, Md. Aftabuddin, R.K. Manna, G. Chandra, A. Biswas, K. K. Sarma and P. Gogoi).

State level workshop on 'NABARD Promotional Scheme for fisheries officials in Assam' jointly organised by NABARD, Guwahati and Dept. of Fisheries, Assam at Silpgram, Guwahati on 30th January 2009 (G. Chandra).

"R & D Sensitization Workshop on Technological Interventions" organized by CSWCRTI on 20th March 2009 (S.N. Singh)

Meetings

Brain storming meet on "Tropic Modeling in marine and Inland ecosystem" at CIFRI centre Bangalore on 23rd Aug. 2008 (attended by S.K. Sahu)

Meeting on "Climate Change in Fisheries and Aquaculture" at the fisheries division ICAR Pusa New Delhi on 15th December 2008 (M.K. Das and S.K. Sahu)

6th meeting of the TMC (Technical Monitoring Committee) meeting for the of Central Sector Scheme "Strengthening of Database and GIS for Fisheries Sector" at Barrackpore on 12th Feb. 2009 (S.K. Sahu, D. Karunakaran, M. Karthikeyan and D. Das)

Meeting on Out-reach Activity on Fish Genetic Stocks organized by the NBFGR, Lucknow on February 16-18, 2009. (B. K. Bhattacharjya)

Training programmes

R. K. Manna and Ganesh Chandra attended- training programme on Administrative and Financial Procedures for CIFRI officers and staffs organized by NAARM, Hyderabad at CIFRI, Barrackpore during April 25-30, 2008.

B. K. Bhattacharjya was deputed by the Department of Agricultural Research & Education, Govt. of India for undertaking study visit to Agriculcultural Research Centre, Egypt in Reservoir fisheries under the Work plan for the year 2007-08 between ICAR & ARC, Egypt during 16-29 August, 2008.

Dr. Md. Aftabuddin attended training programme on Outreach Activity of 'Nutrient profiling and evaluation of fish as dietary component' organized by and held at Central Institute of Fisheries Technology, Kochi during 16-22 September, 2008.

3-days training-cum-workshop on IP and Technology Management organized by NIRJAFT at CIFE Calcutta Centre during 16-18 October 2008.



EVENTS ORGANISED

Fish Farmers' Day

Central Inland Fisheries Research institute (CIFRI), Barrackpore celebrated "National Fish Farmers' Day" at General Auditorium, Sardar Patel Zila Panchayat Bhavan, Vadodara on 10th July 2008. The occasion was graced by Prof. M.C.Varshneya, Vice-Chancellor of Anand Agricultural University, Anand; Dr. K. K. Vass, Director, CIFRI, Barrackpore and Shri L.C.Patel, District Development Officer, Vadodara.



Over 300 persons including 250 fishers and fish entrepreneurs from different regions of Gujarat State and personnel from local ICAR offices, state departments and university and media were present at the function.

Launch Workshop

The Launch Workshop of Outreach Activity-3 entitled



'Nutrient Profiling and Evaluation of Fish as a Dietary Component' involving six institutes under the Fisheries Division, viz. CIFRI, Barrackpore (Lead Institute); CIFA, Bhubaneswar; CIBA, Chennai; CIFT, Cochin; CMFRI, Cochin; and DCFR, Bhimtal. was held at CIFRI, Barrackpore on 31st July- 1st August, 2008. The workshop was attended by Dr K .K Vass, Director, CIFRI, Dr VV Sugunan, AGD (Inland Fisheries), the PIs and Co-PIs from participating institutes and staff Scientists of CIFRI.

CGIAR Challenge Program

Dr. Louis Van Brakel Martin, Scientist at World Fish Centre, Penang, Malaysia visited site of CGIAR Challenge Program on Water and Food project on "Improved fish productivity and management in tropical reservoirs" at Jhansi in Uttar Pradesh and Bhopal in Madhya Pradesh during August 17-22, 2008. He had detailed discussions about the progress and findings of the project with the project staff and representatives from State Department of Fisheries of project states and Bandelkhand and Barkatullah University.

Dr Martin expressed his satisfaction about progress of the project and was impressed by the positive impact of project outputs at both the sites. He had detail discussion with the Project Leader Dr. S. Ayyappan, DDG (Fy) and Executive Project Leader Dr. K. K. Vass, Director, CIFRI, Barrackpore. Dr. Martin also visited CIFRI, Barrackpore and held discussions with institute scientists.



Fisheries enhancement practices at project site near Bhopal

Peninsular Fisheries and Aquaculture meet

A brainstorming meet on *Peninsular Fisheries and Aquaculture* was held at the CIFA/ CIFRI complex, Hessarghatta, Bangalore on 23 August 2008 to discuss matters on :

- Strengthening the existing partnership between ICAR Institutes/Centres and the State/University agencies to enhance the outputs and outcomes of research projects.
- To explore new areas of cooperation among the partners and finding ways to operationalize them
- To set time-bound targets for achieving research outputs of the Institute/Centres.

Dr. S. Ayyappan, DOG (Fy), Dr. V.V. Sugunan, ADG (I. Fy), ICAR, Dr. G. Syda Rao, Director, CMFRI, and Dr. W.S. Lakra, Director, NBFGR attended the meeting.

8th Indian Fisheries Forum

The 8th Indian Fisheries Forum was jointly organized by the Asian Fisheries Society (Indian Branch), Mangalore, the Inland Fisheries Society of India, Barrackpore and the Central Inland Fisheries Research Institute, Barrackpore during 22-26th November 2008 at the Eastern Zonal Cultural Center (EZCC), Kolkata. More than 400 participants, including subject matter experts, stakeholders, farmers, researchers and students from all over the country and abroad attended the Forum. Shri. Kiranmay Nanda, Honorable Minister-in-Charge of Fisheries, Aquaculture, Aquatic Resource and Fishing Harbours, Government of West Bengal inaugurated the Forum in a splendid ceremony. Dr. S. N. Dwivedi, former Additional Secretary, Government of India and President, ASET, Bhopal presided over the function. Dr. Mohan Joseph Modayil, Member, ASRB and Vice President, AFSIB; Dr. M. V. Gupta, World Food Prize Laureate; Dr. S. J. Kaushik, Director, Institute of Hydrology, INRA, France and Shri. R. P. S. Kahlon, Secretary (Fisheries), Government of West Bengal were the

Guests of Honour. Other dignitaries on the dais were Dr. S. Ayyappan, Deputy Director General (Fisheries), ICAR, New Delhi and Chairman, Asian Fisheries Society (India Branch), Dr. K. K. Vass, Director, CIFRI, Barrackpore and President, the Inland Fisheries Society of India; Dr. K. M. Shankar, Secretary, ASFIB and Dr. (Mrs.) K. Mitra, Secretary, the Inland Fisheries Society of India. The Forum was dedicated to *Padamshri* late Dr. V. G. Jhingran, Former Director, CIFRI, Barrackpore and late Dr. G. N. Mitra, Former Fisheries Development Adviser, Government of India. The Forum was conducted in following sessions: Special Session- consisting of talks and lecture on selected topics of contemporary importance, Special Symposia- Fish Diseases, Fish Nutrition and Indian River Systems Theme based Technical Sessions- Fisheries and Aquatic Biodiversity; Aquaculture & Productivity Enhancement, Aquatic Environment & Fish Health, Fish Genetics, Nutrition & Biotechnology' Social Fisheries- Value Addition & Education Poster Session- Based on the five themes. Each session consisted of oral presentations with lead papers by invited experts and presentations of accepted abstracts by registered participants. The valedictory function was held on 25th November, 2008. Md. Anisur Rahman, Hon'ble Minister, Animal Resource Development, Government of West Bengal was the Chief Guest.



Hon'ble Shri Kiranmay Nanda inaugurates the 8th IFF



Special symposium on Fish Disease in 8th IFF

Hindi Pakwara

Hindi Pakhwara was celebrated at the Institute's Headquarters during 15- 29 September, 2008. Prof. Rewa Jajodia, Head, Hindi Department, Bangabasi Evening College, Kolkata inaugurated the Hindi Pakhwara. During this fortnight a number of competitions like *nibandh Lekhan*, *Tippany Lekhan*, *Shabdawali*, *Vyaakhyaan*, *Kavita Path*, *Hindi Patra Lekhan*, *Hindi Nibandh*, *Quiz* etc. were conducted. A large number of officers and staff including scientists participated in these competitions.



The Valedictory function was organized on 29th September, 2008. Dr. R. B. Singh, Joint Director, Central Translation Bureau, Kolkata was the Chief Guest at the function and it was presided over by Dr. K. K. Vass, Director, CIFRI. The message received from Shri Sharad Pawar, Hon'ble Minister of Agriculture, Govt. of India and Dr. Mangla Rai, DG, ICAR, New Delhi was read out. The Chief Guest and the Director, CIFRI distributed prizes to the winners of various Hindi competitions.

Vigilance Awareness Week

Vigilance Awareness Week was observed in the Institute during 3-7th November 2008.

Independence Day

The Independence Day was celebrated at CIFRI with due solemnity. Staff members assembled for the hoisting of the National flag by Director, CIFRI. A cultural function was also organized by the staff members.



Independence Day Celebration at CIFRI

Republic Day

The Republic Day was celebrated at CIFRI with due solemnity. Staff members assembled for the hoisting of the National flag by Director, CIFRI. A friendly Cricket Match between Director-XI and SAO-XI was also organised on this occasion.

DISTINGUISHED VISITORS

The following distinguished persons visited the Institute during the year 2008-09.

Name	Designation & Address
Dr. S. Ayyappan	Deputy Director General (Fy.), ICAR, KAB II, PUSA, New Delhi
Dr. Louis Van Brakel Martin	Scientist, World Fish Centre, Penang, Malaysia
Dr. A. P. Sharma	Vice-Chancellor, G.B. Pant University, Pantnagar
Dr. Mathura. Rai	Director, Indian Vegetable Research Institute, Varanasi
Dr. W.S. Lakra	Director, NBFGR, Lucknow
Dr. P.V. Dehadrai	Chairman, QRT Committee
Dr. Dilip Kumar	Director, CIFE (ICAR), Mumbai
Mr. P. K. Borthakur	Secretary & Commissioner, Fisheries, etc. Departments, Govt. of Assam, Guwahati.
Dr. A. K. Roy	Director of Fisheries, Assam, Guwahati
Dr. A. E. Eknath	Director, CIFA (ICAR), Bhubaneswar
Dr. A. G. Ponniah	Director, CIBA (ICAR), Chennai
Mr. D. Malakar	Managing Director, Assam Fisheries Development Corporation, Guwahati
Mr. W. M. Rizvi,	Chief Director, O/o the Regional Director (NER), National Cooperative Development Corporation, Guwahati
Dr. Angel A. Carbonell- Barrachina	Specialist in Arsenic Chemistry and Professor, Agro Food Technology Department, Miguel Hernández University, Spain
Mr. S. M. Sayyad	Conservator of Forests, Sardar Sarovar Narmada Nigam Ltd.



Mr. Carbenell - Barrachina interacting with CIFRI scientist

PERSONNEL (MANAGERIAL POSITION ONLY, FROM APRIL 2008 TO MARCH 2009)

CIFRI, Barrackpore, West Bengal

Dr. K. K. Vass, Director

Riverine Ecology & Fisheries Division, CIFRI, Barrackpore, West Bengal

Dr. Utpal Bhaumik, Principal Scientist, Head of Division

Fishery Resource & Environmental Management Division, Barrackpore, West Bengal

Dr. Manas Kr. Das, Principal Scientist, Head of Division

Reservoir & Wetland Fisheries Division, Barrackpore, West Bengal

Dr. B. C. Jha, Principal Scientist, Head of Division

Officiating Head, CIFRI, Regional Centre Allahabad, Uttar Pradesh.

Dr. H.P. Singh, Principal Scientist

Officiating Head, CIFRI, Regional Centre Bangalore, Karnataka.

Dr. D.S.K. Krishna Rao, Principal Scientist

Officiating Head, CIFRI, Regional Centre Guwahati, Assam.

Shri V. Kolekar, Principal Scientist

Officiating Head, CIFRI, Regional Centre Vadodara, Gujarat.

Dr. S.N.Singh, Principal Scientist

Officer-In-Charge, CIFRI, Kochi unit, Kerala.

Dr.R.Palaniswami, Principal Scientist

Senior Administrative Officer, CIFRI, Barrackpore.

Shri U.C.Prasad

Finance & Accounts Officer, CIFRI, Barrackpore.

Shri Z.H. Khilji

OTHER RELEVANT INFORMATION

Infrastructure development

During the period, construction of the laboratory on the ground floor at Barrackpore was completed while 1st floor is under completion. A common ICAR Guest House to be jointly constructed by CIFRI, CARI, ICAR Complex Barapani and CAU, Manipur at CIFE centre, Salt Lake, Kolkata has been approved during the XI plan. In this connection a foundation stone was laid by Dr. Mangala Rai, Secretary DARE & DG, ICAR on 8th March, 2009. It is hoped that it will be a land mark in common sharing of resources by different ICAR Institutes under NARS.



Laying of the foundation stone by Dr. Mangala Rai, Secretary DARE & DG. ICAR for ICAR Common Guest House.