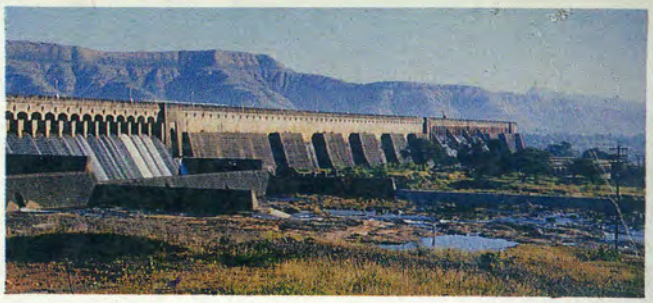


ANNUAL REPORT

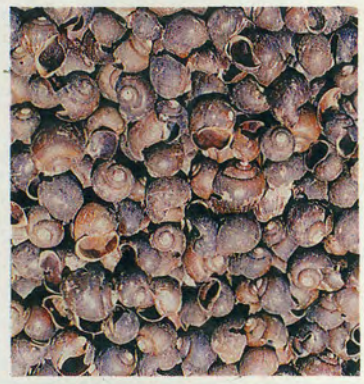
भाकृअनुप
ICAR

1988-89

CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE

BARRACKPORE

WEST BENGAL



ANNUAL REPORT

1988 - 89

CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
Barrackpore 743101 West Bengal INDIA

Credits

Edited and compiled by :	V. V. Sugunan G. K. Vinci V. K. Unnithan
Assisted by :	Anjali De H. Chaklader F. Manna A.K. Banerji
LASER Composing :	H. Chaklader
Assisted by:	F. Manna
Printing:	Md. Quasim
Hindi Translation:	P. R. Rao
Cover design:	P. Dasgupta

Published by :
Arun G. Jhingran,
Director, CICFRI Barrackpore

Printed at :
Documentation Section
CICFRI Barrackpore

CONTENTS

ANNUAL REPORT 1988-89

CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE
BARRACKPORE

BRIEF HISTORY

The Government of India, in a memorandum brought out in 1943, stressed the need for having a separate central department in the best interest of the development of fisheries resources of the country. This memorandum was later endorsed by the Fisheries Sub-committee of the Central Government Policy Committee on Agriculture, Forestry and Fisheries. Based on this, 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 the modest beginning as an interim scheme, the organisation has since grown to the status of a premier research institution in the field of inland fisheries in the country. By the year 1959, the Station acquired its status as Central Inland Fisheries Research Institute (CIFRI) and moved to its own buildings at Barrackpore, West Bengal.

Since 1967, the Institute is under the administrative fold of Indian Council of Agricultural Research (ICAR). The main objectives were to conduct investigations for a proper appraisal of inland fisheries resources of the country and to evolve suitable methods for their conservation and optimum utilisation. While fulfilling the above objectives, the Institute directed its research efforts towards understanding the ecology and production functions of inland water bodies available in the country like the river systems, lakes, ponds, tanks, reservoirs and ox-bow lakes. These studies have unravelled the complex trophic structure and functions *vis-a-vis* the environmental variables in different aquatic ecosystems.

The mandate of the Institute was later modified giving added emphasis on capture fisheries resources of the country and the Institute was rechristened as Central Inland Capture Fisheries Research Institute (CICFRI) with effect from 1.4.1987. Under the changed set up, the CICFRI is entrusted with the responsibility to conduct research on open water bodies where the fisheries management norms are closely associated with environmental monitoring and conservation.

MANDATE

The CICFRI has a mandate to conduct research for developing systems for monitoring and improving fish production in natural and man made inland water resources through stocking, optimum exploitation and conservation.

ORGANISATION

In order to achieve the above mandate the research at CICFRI has been organized under three Divisions corresponding to the major fishery resources of the country. The **Riverine Division,** with its headquarters at **Allahabad,** strives to develop systems for effective management of the vast riverine fisheries resosurces of the country with adequate emphasis on the conservation of riverine environment. The research projects under the Division cover the Rivers Ganga, Yamuna, Brahmaputra and Narmada. The **Lacustrine Division** has its headquarters at **Bangalore** with centres in Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Himachal Pradesh and Maharashtra. The investigations being carried out at the Division aim at developing management norms for optimising fish yields from large tanks, lakes, and reservoirs. The **Estuarine Division** is based at **Barrackpore** and it covers the entire Hooghly-Matlah estuarine system and the Narmada Estuary. The effluents from a number of industrial units, agricultural wastes, municipal wastes etc. make the Hooghly Estuary one of the most polluted stretches of the Ganga river system which is being investigated by the Division. Hilsa being the most important estuarine fish it is being subjected to intensive research. The Institute also conducts investigations on beels of West Bengal and Assam and the ox-bow lakes of the Gandak basin. Other areas covered include cage and pen culture systems in open waters, the ecology and production biology of inland molluscs, engineering aspects of fish passes in hydraulic structures and investigations on fisheries economics and statistics. The Institute's researches have been organized under 20 research projects and a Central Sector Scheme. The work programme of the Institute is carried out through its 15 research centres and 5 survey centres. The distribution of research and survey centres and different sections are shown in the organization chart.

Vigyan Gaon ki aor

Science towards villages was the theme of the grand science mela organised at Gauriganj,Amethi under the auspices of the National Institute of Wastelands and Rural Development from 4.3.89 to 15.3.89. The CICFRI pavilion at the Exhibition was the centre of attraction and an estimated three lakh people visited the stall. Apart from **Prime Minister Rajiv Gandhi**,many top national and State leaders visited the Fisheries Pavilion

Prime Minister at the Fisheries pavilion

Prime Minister Rajiv Gandhi, accompanied by Smt. Sonia Gandhi visited the pavilion on 11.3.89

A panoramic view of the CICFRI Pavilion

Sri Arun Kumar Singh, Fisheries Minister of Uttar Pradesh being ushered into the CICFRI Pavilion by Dr. Arun G. Jhingran, Director, CICFRI

Prof. M.G.K. Menon at CICFRI

Prof. M.G.K. Menon, Scientific adviser to the Prime Minister and member, Planning Commission paid a visit to the Central Inland Capture Fisheries Research Institute, Barrackpore on 2.3.1989. He was accompanied by Mrs. Manju Sharma, Chief, Science, Planning Commission and Shri Sushanta Saha, Dy. Adviser, Planning Commission. Prof. Menon expresed his satisfaction about the visit which he has described as very educative and interesting.

Prof. Menon and Mrs. Sharma being briefed on the activities of biochemistry laboratory.

Prof. M.G.K. Menon at CICFRI

Prof. Menon in the Computer room of CICFRI. Computerised fisheries resource data management system being explained to Mrs. Sharma (left), Prof. Menon (second from right) and Shri Sushanta Saha (right).

The visitors took keen interest in the culture and processing of edible snails. The pictures shows the scientists engaged in the project explaining the snail culture technology developed at the Institute.

IMPORTANT ACHIEVEMENTS

Successful Management of Small Reservoirs

Stocking policy based on studies on spatiotemporal nutrient regime in small reservoirs has proved to be a useful tool for augmenting fish yield from them. This management practice has been shown to be highly remunerative in case of Bachhra reservoir, a 140 ha irrigation impoundment near Allahabad. The impact of stocking has been witnessed this year when fish yield touched an all time high of 139 kg/ha/annum. Stocking has also helped in manipulating the species composition of major carps tilting it in favour of major carp contribution.

Based on this experience, it has been established that future approach towards fisheries development in such ecosystems should be directed towards assessment of their potential yield and formulation of stocking policy based on the framework of ecological parameters obtaining in the environment. Application of the management package is also being tried in the small reservoirs of peninsular India. In Aliyar, a small reservoir on the west flowing drainage, production to the tune of 167 kg/ha has been achieved.

Ulcerative Disease Syndrome in Fishes

The outbreak of ulcerative disease syndrome in epidemic form in fishes of rivers, canals, reservoirs, lakes, paddy fields and ponds of the states of Assam, Tripura and Meghalaya has caused grave concern to the general public and fishery scientists. This is the first time such a disease has been encountered in India.

The disease has been the major concern since 1972 in different parts of Asia-Pacific region. In India, CICFRI, which is monitoring the disease, had warned the various state governments in April, 1988, about the possibility of the disease outbreak in India and in May the prediction came true.

Investigations conducted by CICFRI reveal the following significant features viz.,

a) the affected areas are Jalalpur and Hailakandi sub-division of Cachar district in Assam, West and South districts of Tripura and East Khasi Hills district and Garo Hills districts of Meghalaya. Within these districts the intensity of the disease was severe in the areas bordering Bangladesh.

b) The diseased fishes were mostly found in the rivers, canals, beels, paddy fields and to some extent in the inundated ponds. The area of spread of the disease was upto the spread of the diseased fishes along with the flood waters.

c) Most species of murrels, catfishes and carps were affected, of which the most susceptible species were *Channa striatus, C. punctatus, C. batrachus, Mastocembelus pancalus, M. armatus, Cyprinus carpio, Heteropneustes fossilis, Puntius sophore, Amblypharyngodon mola, Mystus vittatus, and Acrossocheilus hexagonolepis.* The clinical signs in the affected species were red spot lesions which gradually grew to large haemorrhagic ulcers.

d) The affected water areas are characterised by low alkalinity and low hardness, closely correlated to acidic, low calcium soils.

e) The emergence of the disease can be traced to the diseased fishes entering from Bangladesh along with the flood waters where the disease outbreak occurred in February/March, 1988.

f) Because of the outbreak, the marketability of fishes decreased drastically. The remedial measures suggested by CICFRI are application of lime and NaCl in manageable water areas, and fishery officials of the affected states are implementing these measures.

The disease is being monitored under an International Project sponsored by NACA, Bangkok in eleven countries including India at CICFRI, Barrackpore.

Studies on Hilsa population of the Ganga river system

With a view to ascertaining the existence of different races or sub-populations of *Tenualosa ilisha* inhabiting the Ganga river system and the coastal waters of the Hooghly estuary in the Bay of Bengal, racial studies adopting biochemical analysis of the blood serum using electrophoretic technique were conducted on the samples collected from the Bhagirathi-Hooghly estuarine complex and the Ganga-Padma link. Existence of two distinct sub-populations of *Tenualosa ilisha* is evidenced by the difference in distribution pattern and the density of the aminoacid bands of the blood serum protein from the samples of the two stocks examined. The studies will help in identifying the stocks migrating upstream of the Farakka Barrage and adopting suitable conservation and management measures for development of hilsa fisheries in the upper stretches of the Ganga river system.

Energy Dynamics of Riverine Ecosystem

The limnological investigations conducted at different stretches of the Rivers Ganga and Yamuna brought to relief some significant variations in transformation of incident solar energy into chemical energy at the primary producer level. The photosynthetic organisms (primary producers) fixed 0.02-0.27% of solar energy at Kanpur, compared to 0.06-1.10% at Allahabad and 0.083 to 0.53% at Patna. Based on the level of

energy stored at the primary producer level, the fish yield potentials at Kanpur, Allahabad and Patna were estimated to be 74, 249 and 192 kg/ha/year respectively. Similar studies were conducted at two places in River Yamuna near Allahabad where the energy transfer from sunlight to primary producers ranged within 0.025 and 0.480%. The harvestable fish production from Yamuna at Allahabad was estimated at 107 kg/ha/year. The studies clearly indicated that the anthropogenic changes in the habitat variables have impaired the biological production process and the basic productivity levels leading to poor fish harvest.

COLLABORATION

The Institute had a number of national and international collaborative research activities during 1988-89.

National

The Government of Tamil Nadu has actively collaborated with Central Inland Capture Fisheries Research Institute (CICFRI) in the execution of the project **"Ecology and fisheries of the small reservoir in Aliyar basin"** at Aliyar Reservoir, Tamil Nadu, by extending the farm and transport facilities.

Apart from these CICFRI was engaged in assisting different agencies in the fishery developmental activities through its consultancy services.

CONSULTANCY SERVICES PROVIDED BY CICFRI

Project on integrated Fisheries Development of North Eastern States - A CICFRI-AFC collaborative venture :

The Central Inland Capture Fisheries Research Institute has been retained as consultants by the Agricultural Finance Corporation (AFC) for preparing a massive fisheries development master plan for the North Eastern States. The project covers all the seven North Eastern States and Union Territories viz., Assam, Meghalaya, Mizoram, Nagaland, Manipur, Tripura and Arunachal Pradesh. The project envisages to develop the vast fisheries resources available in the region such as rivers, ox-bow lakes, natural lakes, reservoirs, upland lakes and mountain streams. Possibilities of developing paddy-cum-fish

culture of integrated farming systems are also covered under the project. A team of scientists has completed the field studies and submitted the draft report.

Environmental Impact Assessment study at Paradip Port

The Institute has offered consultancy services to Consulting Engineering Services India Pvt. Ltd. to collect base line data on the environmental impact assessment in Paradip Port area in the wake of the expansion project for the existing iron ore handling facility at the port. The study was needed to obtain clearance from the Ministry of Environment as per the guidelines. The study covered, physical, chemical, and biological parameters with special emphasis on the total inventory of pollutants entering the marine environment from public domain like municipal wastes, heavy metals, hallogenated hydrocarbon products and petrochemicals. Data on flora and fauna in marine and estuarine environment, microbial activity and plankton were covered under the study. The work has been completed in December 1988.

Environmental Impact Assessment study at Hazaribagh

Studies have been conducted on the environmental impact assessment of North Karanpura Super Thermal Power Project near Hazaribagh. Report of the aquatic ecology of the area, in the context of the proposed power plant was prepared and submitted under a consultancy assignment.

International

Central Inland Capture Fisheries Research Institute has actively collaborated with the *Network of Aquaculture Centres in Asia (NACA)* in their Regional Research Project entitled **"Environmental Monitoring and Ulcerative Syndrome in Fish"** was initiated at CICFRI, Barrackpore, India along with 11 other countries. The principal objective of the project is to establish the relationship between the ulcerative disease syndrome in fish and the environment. Under the technical programme, fortnightly diurnal fluctuation of physico-chemical parameters, heavy metal and pesticide analysis, fish population monitoring and haematological study was done in two impoundments in rain-fed and irrigated paddy field areas during the year 1988-89. The Project reports were submitted to NACA and presented in the **'First Workshop on Ulcerative Fish Disease and Environment'**, 20-24 March 1988, Bangkok, Thailand. The recommendations from the workshop emphasise the urgent need to continue the regional research programme as invited by NACA.

Indo-Dutch Training Programme

The Institute is organising an **Indo-Dutch Training Programme** on ***'Environment Impact Assessment'*** to be conducted at Barrackpore. The programme will cover the methodologies for environment impact assessment in the country with appropriate case studies. The programme is jointly sponsored by CICFRI and the Dept. of Environment, Govt. of India. Apart from the inhouse experts, specialists from the Netherlands also will contribute in the 6 day training programme.

FAO-Danida Training on Fish Stock Assessment

An FAO-Danida Training Programme on ***Fish Stock Assessment*** is being arranged at CICFRI, Barrackpore with a view to upgrading the skill of technical personnel engaged in the fish stock assessment. The project is being funded by FAO and Danish Govt. and expected to train participants from various state governments of the country apart from 5 fisheries officials from Bangladesh.

MANPOWER DEVELOPMENT

Sarvashri Ch. Gopalakrishnayya, R.A. Gupta, G.K. Bhatnagar and Dr V.R. Desai, Scientists 3 of this Institute underwent training course on **Human Resources Management** held at **NAARM,** Hyderabad from 1st August 1988 to 12th August 1988.

Shri S.K. Mondal, Scientist 2 underwent **FAO/DANIDA/FSI National Training Course and Workshop on Fish Stock Assessment** held at Visakhapatnam from 14th November 1988 to 14th December 1988.

Sarvashri H. Chaklader, A.K. Banerjee and F. Manna, T-II-3 and **Miss S. Talapatra** and **Miss S. Biswas, Junior Clerks** of this Institute underwent training on **Apple Desktop Photocomposing/Photo-type Setting System** at M/s. Rahul Commerce (P) Ltd., Calcutta from 6th December 1988 to 9th December 1988.

Shri A.K. Banerjee, T-II-3 of this Institute was trained on **Information Storage & Retrieval System (ISRS)** at National Institute of Small Industry Extensionn Training, Hyderabad from 16th January 1989 to 3rd February 1989.

Dr. Arun G. Jhingran, Director, attended 12 day course on **"Management Development Programme for Senior Executives of ICAR Institutes",** conducted by the National Academy of Agricultural Research Management, Hyderabad from 30th January to 10th February 1989.

Dr. M. Chaudhury, Scientist 1 of this Institute underwent training programme on **Acoustic Techniques for Fish Abundance Estimation** at Integrated Fisheries Project at Cochin from 13th February 1989 to 23 February 1989.

HONOURS, AWARDS, ETC.

D. Nath, Scientist 2 of this Institute was awarded the *Ph.D.* degree in Agricultural Chemistry & Soil Science from Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal.

V.R. Chitranshi, Scientist 2 was awarded Ph.D. degree on topic entitled **Studies on Ecology and Productivity of Certain Mauns (ox-bow lakes) of River Burhi Gandak** from University of Bihar (Muzaffarpur).

D.K. De, Scientist 2 was awarded Ph.D. degree on his thesis entitled **Studies on the food and feeding habit of Hilsa ilisha (Ham.) of the Hooghly Estuarine System and some aspects of its biology** from University of Calcutta.

M. Chaudhury, Scientist 1 at Guwahati Centre was awarded the Ph.D. degree by the University of Guwahati for his thesis entitled **Some aspects of Biostatistical Studies on catch, growth and ecological parameters of freshwater Indian major carps in the lower reach of River Brahmaputra, Assam (India).**

TRANSFER OF TECHNOLOGY

EXTENSION AND NATION-BUILDING ACTIVITIES

The Central Inland Capture Fisheries Research Institute continued to be in the forefront of extension activities to help farmers, entrepreneurs, government agencies, financial institutions as well as voluntary organisations through extending the fishery management technologies. Transfer of technologies was implemented through the following activities.

Training Programmes

Training in techniques of fisheries management was imparted to progressive fish farmers through various programmes.

Workshop - cum - Training on Snail Culture

The Central Inland Capture Fisheries Research Institute in collaboration with the Marine Products Development Authority (MPEDA) has conducted a Workshop-cum-Training Programme on Snail Culture, with a view to disseminating the technology developed by the Institute to entrepreneurs and exporters. Twenty three top exporters of the country took part in the deliberations that lasted for 9 days from 14.6.1988 to 22.6.1988.

The participants took keen interest to learn about the natural populations of the edible snail, *Achatina fulica* and its production potential from nature. Breeding, hatching, larval rearing and culture of snails in different culture systems were explained to them. The trainees were taken to a private processing plant at Calcutta where the processing and packing of the products were demonstrated to them.

The participants were highly motivated and they have resolved to initiate an overseas trade in giant African snail, *Achatina fulica*. A 14 point recommendation adopted by the workshop urged the Central Government to grant liberal subsidies for the export of this unconventional item with a view to diversifying the range of marine products.

During 1988-89, six major training programmes were conducted by the Institute. Details are as follows :

Sl.No.	Subject	Period of training	Beneficiaries
1	Chinese hatchery Operation	23.3.88-30.3.88	Dr.K.G.Padmakumar Kerala Agricultural University, Kerala
2.	Collection and preservation of museum specimens	24.3.88-29.3.88	Mr. Iqbal Ahmad, Rajendra Agricultural University, Bihar
3.	Freshwater Aquaculture	2.5.88-5.5.88	41 fish farmers of West Bengal
4.	Induced breeding of carp	2.7.88	91 students from Bidhan Chandra Krishi Viswa-Vidyalaya, Kalyani
5.	Snail farming	14.7.88-22.7.88	23 exporters from different states
6.	Composite fish culture	6.10.88	30 fish farmers of West Bengal

Group Discussions

Group discussions were held for more than 200 fish farmers at different places of West Bengal in order to build a better rapport between ultimate beneficiaries of the research and the researchers.

Exhibitions

The Institute participated in 4 exhibitions organised by different agencies in various parts of the country. Two exhibitions were arranged, exhibitions one at Barrackpore and the other at Bhola village of West Bengal to make the public aware of the latest developments in fisheries.

Fish Farmers' Day

Organised several Fish Farmers' Days in various villages of the country.

Oilseeds Demonstration Programme

National oil seed demonstration programme was initiated in village Naukpul in a 4 ha land. Improved variety of mustard B-9 with fertilizer was distributed among 15 farmers. In the villages of Salna, Nagla and Ballgachi mustard seeds were distributed among 31 farmers.

Seed Supply

Supply of about 30,80,000 fry/fingerlings of major carps was arranged for various governmental organisations for their use. Besides this, fry of Chinese carps and *Oreochromis mossambicus* were distributed for research purposes to various research institutes.

Talks Delivered

Extension scientists of the Institute delivered more than 45 talks at different extension functions for the benefit of fish farmers, students and extension officers from various State Governments.

Extension Studies

A study on acceptance of exotic carps among fish farmers was conducted by the scientists. The study revealed the public preference for silver carp than for common carp or grass carp.

Another study showed that among communication methods radio played maximum role in transmission of information to the clientele followed by newspapers, films, demonstrations, fish farmers' days, exhibitions, television etc.

Mass Awareness Day

A 'Mass Awareness Day' was organised at Bhola village of Hooghly District (West Bengal). About 300 fish farmers attended the function.

LIBRARY & DOCUMENTATION SERVICE

Library

The CICFRI library had acquired 93 latest books, 22 reprints of scientific papers and subscribed 36 foreign and 59 Indian journals. The library had a total holding of 6,121 books, 4,146 reprints, 747 maps and 2,580 miscellaneous publications. The library maintained exchange relationship with more than 300 leading national and international research information centres. About 34 new exchange relationships were established during the year.

The library maintained free mailing of Institute publications to various research organisations, universities, entrepreneurs, and farmers to keep them abreast with the latest developments in fisheries research. As a part of resource sharing it lented out 62 publications to other libraries on inter-library loan. The total expenditure incurred by the library during the year was Rs.3,34,876.00.

Reprography Services

The Section maintains an active unit for photography and reprography services. Photographs, reprints and photocopies were supplied to the scientists of the Institute as well as of other research institutes and universities free of cost.

The Section also maintains a duplicating (cyclostyling) and binding unit to serve the various units of the Institute.

Technical Reports

More than 30 technical reports on the progress of research activities of the Institute were compiled. Research publications of the Institute scientists were scrutinised before publication in various journals. Technical queries regarding the activities of the Institute from various quarters of the country and abroad were attended to by the Section.

Participation of scientists of the Institute in Seminars, Symposia, Conferences, etc. was monitored by the Section.

Information Services

RESEARCH PROJECT FILES

Annual progress reports of all the research projects and the contribution of scientists of the Institute were recorded in the Primary Project Files and Scientists' Files. Research progress monitoring is one of the major responsibilities of the Section.

Publications

The following departmental publications were brought out by CICFRI during the year April 1988 to March 1989.

1. **Annual Report** for the year 1987-88

2. **Bulletin No. 53 :** Synopsis of biological data on the giant murrel *Channa marulius* (Hamilton 1822), the striped murrel *Channa striatus* (Bloch 1793) and the spotted murrel *Channa punctatus* (Bloch 1793) by S. Parameswaran and M.Y. Kamal.

3. **Bulletin No. 54 :** Selection of site, survey, design and construction of brackishwater fish farm with special reference to the islands of lower Sunderbans by A. Sengupta and D.D. Halder.

4. **Bulletin No. 56 :** Farming of the giant african snail, *Achatina fulica* - a manual by G.K. Vinci, V.K. Unnithan and V.V. Sugunan.

5. **Bulletin No. 57 :** Conservation and Management of Inland Capture Fishery Resources Ed. by Arun G. Jhingran & V.V. Sugunan. (Lectures delivered at the Summer Institute on the Resource Management and Conservation of Inland Capture Fisheries of India, 4-23 July, 1988, CICFRI, Barrackpore.

6. **Bulletin No. 58 :** Collection and estimation methodology of inland fisheries statistics in India - a manual by R.A. Gupta, S. Paul & S.K. Mondal.

7. **Activity Milestones** of Research Project Programmes, 1988-89.

8. **International Seminar on Wastewater Reclamation and Reuse for Aquaculture,** 6-9 December 1988, Calcutta. Papers presented on Wastewater Aquaculture - ed. by Arun G. Jhingran, Dhrubajyoti Ghosh & Apurba Ghosh. (Organised by Economic and Social Commission for Asia and the Pacific, Ministry of Agriculture, Government of India & Dept. of Fisheries, Govt. of West Bengal.

9. Research Highlights, 1987-88.

10. **CICFRI Brochure.**

CONFERENCES, SYMPOSIA ETC.

The following important Meetings/Symposia etc. were organised by the Institute during April 1988 to March 1989.

Annual Staff Research Council Meeting of the Institute from 18-20th April 1988.
World Environment Day on 5th June 1988.
Summer Institute on "Conservation and Management of Inland Capture Fishery Resources" from 4th-23rd July 1988.
Hindi Day celebration on 17th September 1988.
National Seminar on " Management of Fisheries in Inland Open Water Systems of India" from 14th-16th December 1988.
National Science Day celebration on 28th February 1989.

The scientists of the Institute participated in various conferences/symposia/seminars and meetings held during 1988-89 wherein they presented their research findings and exchanged views with the delegates. List of scientists who participated/presented papers in such gatherings is furnished below :

Conferences/Symposia	Organised by	Papers presented	Authors/Participants
1	2	3	4
Workshop on Exotic Aquatic Species in India (25-26 April 1988)	Asian Fisheries Society (Indian Branch), Mangalore	Status of exotic fishes in India in capture fishery waters	Arun G. Jhingran
-do-	-do-	Parasitic fauna of cultured exotic carps in India - Its biological significance	M.K. Das
-do-	-do	Lates calcarifer as a bio-controlling agent for *Oreochromis mossambicus* in sewage-fed impoundments	Apurba Ghosh, Amitabha Ghosh, P.K. Chakraborti and G.N. Chattopadhyay
-do	-do	Impact of the exotic fish, *O. mossambicus* on the indigenous fishes of Powai lake, Bombay	M.J. Bhagat and S.N. Dwivedi
-do	-do	Prospects for developing an export trade of the Giant African Snail	Arun G. Jhingran, V.V. Sugunan, V.K. Unnithan and G.K. Vinci
National Symposium on Environmental impact on animals and aquaculture (14-16 May 1988)	Kalyani, West Bengal	Effect of certain selective environmental factors on the natural spawning of Indian major carps	S.K. Wishard, Balbir Singh and S.N. Mehrotra

NATIONAL SEMINAR ON INLAND OPEN WATER SYSTEMS OF INDIA

A National Seminar on Management of Inland Open water Systems in India was jointly organised by the Institute and Inland Fisheries Society of India at CICFRI during 14-16 December 1988. The Seminar aimed at reviewing the present level of knowledge on the subject, consolidating the information and suggesting policies and strategies for conservation and optimum utilization of the inland open water systems of the country.

The seminar was inaugurated by Shri Kironmoy Nanda, Hon'ble Minister for fisheries, Government of West Bengal (seated second from right). Dr. A.N. Bose, Ex-Vice Chancellor, Jadavpur University (second from left) presided over the function. Dr. Arun G. Jhingran, Director, CICFRI (extreme right) welcomed the delegates and Dr. M.Y. Kamal, Assistant Director-General, ICAR, New Delhi (extreme left) proposed the vote of thanks.

On the occasion Dr. V.G. Jhingran, the noted fisheries scientist and Ex-Director, CIFRI and Shri Nil Ratan Ghosh, a progressive fish farmer were falicitated by the Inland Fisheries Society of India. Dr. Jhingran was honoured for his contribution towards the advancement of inland fisheries research and development in the country (photo on the top). Shri Ghosh was honoured for his inspiring and untiring efforts to build up a large-scale aquaculture venture thereby setting an example for other fish farmers of the country.

A view of the delegates. Over 110 participants representing Central and State Government Departments, research institutions, Universities and financing institutions participated in the seminar. They presented over 50 papers and participated in the four technical sessions of the seminar.

Prof. H.P.C. Shetty, Director of Instructions, College of Fisheries, Mangalore (second from right) chaired the plenary session. Twenty recommendations were finalised in the session which have far -reaching influence on the open water fisheries management in the country. Dr. Arun G. Jhingran (extreme right), Dr. M.Y. Kamal (second from left) and Mr. V.V. Sugunan are also seen on the dais

Seminar.....

Shri Kironmoy Nanda, Hon'ble Minister for Fisheries, Govt. of West Bengal being presented with the seminar materials and Institute publications by Dr. Arun G. Jhingran (top). Mr. Nanda in the aquarium hall of the Institute (below).

An International seminar on **Waste Water Reclamation and Reuse for Agriculture** sponsored by World Bank and ESCAP was conducted by the Institute in collaboration with the Ministry of Agriculture, Government of India and Department of Fisheries, Government of West Bengal during 6-9 December 1988 at Park Hotel, Calcutta . In the picture above Mr. Shyam Lal Yadav, Hon'ble Minister of State, Govt. of India is seen delivering the inaugural address. Dr. B.C. Sarma, Jt. Secretary (Fisheries), Ministry of Agriculture, Govt. of India (extreme left), Shri Kiranmoy Nanda, Hon'ble Minister for Fisheries, Govt. of West Bengal (right to Shri Yadav), Shri Sujit Banerjee, Secretary, Department of Fisheries, Govt. of West Bengal and Dr. Arun G. Jhingran, Director, CICFRI (extreme right) are also seen in the picture.

Dr. Arun G. Jhingran, Director, CICFRI is seen welcoming the delegates in the picture below. Mr. C.R. Bartone (World Bank) and Mr. S.Z., Khan (ESCAP) are also seen in the picture in addition to Dr. B.C. Sarma, Shri Shyam Lal Yadav and Shri Kiranmoy Nanda.

Workshop on Snail Farming

A **workshop-cum-training programme** was organised by the CICFRI in collaboration with the Marine Products Export Development Authority, Cochin to disseminate the know-how on snail breeding, farming and meat processing from 14-22 June, 1988. Twenty three participants comprising seafood exporters, entrepreneurs and industrialists took part in the deliberations.

The workshop was inaugurated by Prof. A.B. Dasgupta (right), Deputy Chairman, State Planning Commission, West Bengal. Prof. A.N. Bose (middle seated) and Dr. M. Saktivel (left seated), Director, MPEDA were present at the function. Dr. Arun G. Jhingran, Director, CICFRI speaks on the occasion.

Processing of snail at a sprivate processisng plant at Calcutta

Workshop on Snail Farming

Processed snail meat ready for quick freezing

Mr. O.P. Dhamija, (third from left), Joint Director, Export Inspection Agency visiting the snail house at CICFRI.

Summer Institue on Capture Fisheries

A Summer Institute on **'The Resource Management and Conservation of Inland Capture Fisheries of India'** was organised at Barrackpore from 4-23 July 1988. Twentyfive participants drawn mainly from the Univerisities and research organizations were appraised of the latest developments in the field of inland capture fisheries through lectures, practical demonstrations and field visits.

Dr. V.G. Jhingran, noted Fisheries Scientist (second from right) inaugurated the Summer Institute. Also seen in the picture are (from left) Dr. Arun G. Jhingran, Director, CICFRI, Prof. G.K. Manna, University of Kalyani and Shri Apurba Ghosh, Scientist, CICFRI.

Participants in the radioisotope laboratory

Summer Institue on Capture Fisheries

Summer Institute participants being taken to Namkhana in lower Hooghly estuary.

Sampling methods for hydrobiological investigations being demonstrated to the Summer Institute participants.

VISITORS

Dr. Sena S De Silva, (left), University of Ruhina, Sri Lanka accompanied by Dr. J. R. Arthur, (second from left) of the IDRC Singapore paid a visit to the CICFRI on 22.2.1989. They are seen in discussion with Dr. Arun G. Jhingran.

Dr. S. C. Singhal of the American Soybean Association, New Delhi accompanied by Ms. Mali Boonyaratpalin, National Inland Fisheries Institute, Bangkok visited the Institute on 11.7.89.

VISITORS

Dr. C. Natarajan, Director, Department of Biotechnology, Govt. of India visited the Institute on 27.9.1988. Dr. Natarajan is seen in discussion with Dr. Arun G. Jhingran, Director, CICFRI.

Dr. R.P.S. Tyagi, Member, Agricultural Scientists' Recruitment Board visited the Central Inland Capture Fisheries Research Institute to apprise himself with the progress made by scientists in their respective projects. He had personal discussions with each scientist of the headquarters.

EXTENSION AND TRAINING

Exhibitions : The Institute participated in several national exhibitions during the year. **Above :** Visitors to the CICFRI pavilion 'Our India exhibition' organised at Kohima, Nagaland.

Fish Farmers' Days : In one of the FFDs organised by the Institute, the farmers at Bhola village, Hooghly Dist. are explained the scientific methods of fish raising.

Demonstrations : A field demonstration of fish pond management in South 24 Parganas, West Bengal.

1	2	3	4
National Symposium on Environmental impact on animals and aquaculture (14-16 May 1988)	Kalyani, West Bengal	Observation of the periphyton production in a peninsular tank	.D.S. Krishna Rao
Workshop on Environmental pollution, control and management (29-30 July 1988)	Grand Hotel, Calcutta		H.C. Joshi
Workshop on Snail Farming (14-22 July 1988)	Jointly organised by MPEDA & CICFRI, Barrackpore	Farming of the Giant African Snail, *Achatina fulica*	Arun G. Jhingran, G.K. Vinci, V.K. Unnithan, V.V. Sugunan, S. Paul A.B. Mukherjee
Summer Institute on the Resource Management and Conservation of Inland Capture Fisheries of India (4-23 July)	CICFRI, Barrackpore	Potential and scope for development of inland capture fisheries resources of India	Arun G. Jhingran
-do	-do-	Role of exotic fishes in capture fishery waters of India	Arun G. Jhingran
-do-	-do-	Production biology of riverine fish	M.A. Khan

1	2	3	4
Summer Institute on the Resource Management and Conservcation of Inland Capture Fisheries of India (4-23 July 1988)	CICFRI, Barrackpore	Riverine fisheries resources of the Ganga and the Brahma-putra	Ravish Chandra
-do-	-do-	Fishing methods in river systems	R.K. Saxena
-do-	-do-	Recycling of sewage effluents through fish production - A means to combat riverine pollution	Apurba Ghosh
-do-	-do-	Impact of man-made environmental modifications on the riverine ecology and productivity - A case study of the River Ganga	H.C. Joshi
-do-	-do-	Man-induced environmental deterioration in the Damodar river system	R.K. Banerjee
-do-	-do-	Salient features of reservoir limnology and their significance to fisheries development	V.V. Sugunan

1	2	3	4
Summer Institute on the Resource Management and Conservation of Inland Capture Fisheries of India (3-23 July 1988)	CICFRI, Barrackpore	Management norms for large, medium and small reservoirs	M. Ramakrishniah
-do-	-do-	Riverine flood plain fishery of the Brahmaputra basin	Y.S. Yadava
-do-	-do-	Fisheries potential and management of oxbow lakes of Ganga and Brahmaputra basins	V.Pathak, M.J. Bhagat and (Mrs.) K. Mitra
-do-	-do-	Pen and cage culture of fishes in oxbow lakes	V.R. Chitranshi
-do-	-do-	Engineering aspects of cage and pen designs	A.B. Mukherjee
-do-	-do-	Tank fishery resources of India	B.V. Govind and P.K. Sukumaran
-do-	-do-	Limnology, productivity and fisheries of upland lakes	K.K. Vass
-do-	-do-	Role of sampling theory in stock assessment in inland capture fisheries	R.A. Gupta

1	2	3	4
Summer Institute on the Resource Management and Conservation of Inland Capture Fisheries of India (3-23 July 1988)	CICFRI, Barrackpore	Status of estuarine fisheries resources and their exploitation in India	B.N. Saigal and M.K. Mukhopadhyay
-do-	-do-	Impact of Farakka Barrage on the estuarine ecology of Hooghly-Matlah system	P.K. Chakraborti and G.N. Chattopadhyay
-do-	-do-	Biology and migration of Hooghly hilsa in the context of Farakka Barrage	D.K. De, Amitabha Ghosh and V.K. Unnithan
-do-	-do-	Impact of pollution in Hooghly-Matlah estuarine system	B.B. Ghosh, H.C. Joshi and M.M. Bagchi
-do-	-do-	Fisheries resources management of sewage-fed wetlands of Calcutta spill area	Apurba Ghosh, G.N. Chattopadhyay, Amitabha Ghosh and R.K. Das
-do-	-do-	Common fish parasites encountered in estuarine wetlands and their control measures	R.N. Pal, A.K. Ghosh and M.K. Das

1	2	3	4
Summer Institute on the Resource Management and Conservation of Inland Capture Fisheries of India (3-23 July 1988)	CICFRI, Barrackpore	Role of mangroves in estuarine fisheries development	P.K. Chakraborti and
-do-	-do-	Some considerations in management of coastal lagoons with special reference to the fisheries of the Chilka, the Pulicat and the Vembanad lakes	Ch. Gopalakrishnayya
-do-	-do-	Use of radio-isotopes and ^{14}C in the productivity studies of inland waters	Babu Lal
-do-	-do-	Methods of studying the population dynamics of estuarine fishes	S.K. Mondal, P.M. Mitra and H.C. Karmakar
-do-	-do-	Studies on the diet and digestive rate in predator species - A method employing dual applications of disc-gel electrophoresis and densitometric scanning	Ansuman Hajra

1	2	3	4
Summer Institute on the Resource Management and Conservation of Inland Capture Fisheries of India (4-23 July 1988)	CICFRI, Barrackpore	Project appraisal of aquatic production systsem	S. Paul
-do-	-do-	Certain issues in economics of production and marketing of inland fish	S. Paul
-do-	-do-	Role of extension in the inland capture fisheries research	D.D. Halder, U. Bhaumik, P.K. Pandit and J.G. Chatterjee
National Workshop on Carp Seed Production Technology (2-4 September 1988)	Asian Fisheries Society, A.P. Agricultural University and Fish Farmers of A.P., Eluru	Natural Seed Resources and Artificial Propagation of Indigenous carp - *Schizothorax* sp. in Kashmir	K.K. Vass and M.J. Bhagat
-do-	-do-	Report on observations on breeding of carps in bundhs in West Bengal	Ch. Gopalakrishnayya
-do-	-do-	Fish seed production of major carps at Badampudi Fish Farm in A.P.	J.B. Rao

1	2	3	4
National Workshop on Carp Seed Production Technology (2-4 September 1988)	Asian Fisheries Society, A.P. Agricultural University and Fish Farmers of A.P., Eluru		R.S. Panwar
National Seminar on Nuclear and allied techniques in agriculture, medicines and environment research (6-9 September 1988)	Indian Agriculture Research Institute (I.A.R.I.), New Delhi	Heavy metals in water, sediments and fish in River Yamuna	H.C. Joshi
-do-	-do-		R.K. Das and R.K. Banerjee
Workshop on Finance for Fish Farming and Prawn Farming Projects (26 September 1988)	National Bank for Agriculture and Rural Development at Bangalore		B.V. Govind
National Symposium on fish and their environment (21-23 November 1988)	Dept. of Aquatic Biology & Fisheries, University of Kerala, Trivandrum	Pond seepage - A major threat to Aquaculture	A.B. Mukherjee
National Conference on Management of Lakes and Inland Water Bodies (24-26 November 1988)	Institute of Public Health Engineers, Puri, Orissa	Strategies for the conservation and Management of oxbow lake resources	Y.S. Yadava

1	2	3	4
53rd Annual Convention of Indian Society of Soil Sciences (24-27 November 1988)	Indian Society of Soil Science, Divn. of Soil Science & Agriculture Chemistry, I.A.R.I., New Delhi, held at Bhubaneswar	Nutrient harvest from waste water recycling through fish culture	G.N. Chattopadhyay and Apurba Ghosh
National Seminar on Agriculture Marketing (25-26 November 1988)	Dept. of Agricultural Economics, Assam Agricultural University, Jorhat	Accelerating the pace of fishery development through market investigation	Arun G. Jhingran and S. Paul
Symposium on Water Pollution, Agriculture and Environment (27-28 November 1988)	Sheila Dhar Institute of Soil Sciences, Allahabad		K. Chandra
International Conference on Appropriate Agricultural Technologies for farm women - Future Research Strategy and Linkage with Development Systems (30 Nov.-4 Dec, 1988)	Dr. C. Prasad, Dy Director General (Agril. Extn.), I.C.A.R., New Delhi, held at Vigyan Bhavan, New Delhi	Involvement of fisherwomen in the development of inland fisheries	D.D. Halder, Utpal Bhowmik, P.K. Pandit and J.G. Chatterjee
-do	-do-		Arun G. Jhingran, G.K. Vinci, Usha Moza, Krishna Mitra

1	2	3	4
International Symposium on Reclamation of Wetland and reuse of Waste Water in Agriculture (6-9 December 1988)	ESCAP, World Bank; Govt. of India & Govt. of West Bengal, at Calcutta	Productive utilization of sewage effluent through aquaculture - a case study	Arun G. Jhingran and Apurba Ghosh
-do-	-do-	Environmental and sanitary aspects of wastewater recycling for productive use	Apurba Ghosh, G.N. Chattopadhyay and P.K. Chakraborti
-do-	-do-	Socio-economic dimensions of waste recycling with special reference to sewage fed fisheries	S. Paul
-do-	-do-	A modular project for recycling sewage effluents through aquaculture and its economic viability	Apurba Ghosh, G.N. Chattopadhyay and A.B. Mukherjee
National Seminar on Management of Fisheries in Inland Open Water System of India (14-16 December 1988)	Jointly organised by Central Inland Capture Fisheries Research Institute (CICFRI) and Inland Fisheries Society of India, Barrackpore	Management of small reservoirs in India for fishery development	Arun G. Jhingran
-do-	-do-	Technology for fisheries management in oxbow lakes	Y.S. Yadava

1	2	3	4
National Seminar on Management of Fisheries in Inland Open Water System of India (14-16 December 1988)	Jointly organised by Central Inland Capture Fisheries Research Institute (CICFRI) and Inland Fisheries Society of India, Barrackpore	On conservation and management of fisheries in upland lakes	K.K. Vass
-do-	-do-	Fisheries management in Indian peninsular tanks	V.V. Sugunan & V.K. Unnithan
-do-	-do-	Availability of fish and prawn seed with reference to water qualities in estuaries of some river systems irrigating bheries	G.N. Saha, G.C. Laha, S.C. Thakurta, P.K. Ghosh, A.C. Nandy and S.K. Chatterjee
-do-	-do-	Primary production, energy fixation and potential fishery of Hooghly-Matlah estuarine system	Arun G. Jhingran and Babu Lal
-do-	-do-	Ecology of sewage-fed saline wetlands in relation to fish production	Apurba Ghosh, G.N. Chattopadhyay, Amitabha Ghosh, R.K. Das, P.K. Chakraborti and K.R. Naskar

1	2	3	4
National Seminar on Management of Fisheries in Inland Open Water System of India (14-16 December 1988)	Jointly organised by Central Inland Capture Fisheries Research Institute (CICFRI) and Inland Fisheries Society of India, Barrackpore	Fisheries resources of inland open water systems of Himachal Pradesh and their present level of management	Kuldip Kumar
-do-	-do-	Role of parasites as biological tags to study migratory behaviour of fishes in open water system	Ajoy Kumar Ghosh, G.C. Laha and R.N. Pal
-do-	-do-	Environmental constraints in management of fisheries in inland open water systems in India	H.C. Joshi
-do-	-do-	Different types of tidal mangroves of the Sunderbans and their role on estuarine fisheries	Kumudranjan Naskar, G.N. Chattopadhyay, P.K. Chakraborti and N..N. Mazumder
-do-	-do-	Fishery management - A probe into levels of employment and income in selected reservoirs	S. Paul and V.V. Sugunan

1	2	3	4
National Seminar on Management of Fisheries in Inland Open Water System of India (14-16 December 1988)	Jointly organised by Central Inland Capture Fisheries Research Institute (CICFRI) and Inland Fisheries Society of India, Barrackpore	Ecological studies of the aquatic environment of a large deep water rice field at Piarapur in Hooghly District, West Bengal	D.N. Das, B. Roy, P.K. Mukhopadhyay, Krishna Mitra and A.C. Nandy
-do-	-do-	The periphyton of Govindsagar reservoir, Himachal Pradesh : Abundance and periodicity of diatoms	B.C. Jha
-do-	-do-	Effects of certain hydrological and meteorological factors on the riverine carp spawn abundance in a stretch of River Yamuna near Allahabad	R.K. Dwivedi, K.P. Srivastava, N.K. Srivastava, R.K. Tyagi and Ravish Chandra
-do-	-do-	Needs for management : Krishnarajasagar reservoir, a case study	B.V. Govind, D.S. Krishna Rao, P.K. Sukumaran and M.F. Rahman
-do-	-do-	Observations on different trophic phases in a tropical impoundment Nagarjunasagar, Andhra Pradesh	M. Ramakrishniah
-do-	-do-	Epizootic ulcerative syndrome in fishes of Eastern India : a preliminary account	Arun G. Jhingran and M.K. Das

1	2	3	4
National Seminar on Management of Fisheries in Inland Open Water System of India (14-16 December 1988)	Jointly organised by Central Inland Capture Fisheries Research Institute (CICFRI) and Inland Fisheries Society of India, Barrackpore	Observations on the bathymetric distribution of benthos in Gobindsagar reservoir, Himachal Pradesh	D.K. Kaushal and A.P. Tyagi
-do-	-do-	Studies on the species diversity - succession and abundance in phytoplankton of the Hooghly estuary	A.C. Nandy, M.M. Bagchi, S.K. Majumder and B.K. Saha
-do-	-do-	A modified technology for segregation of qualsity fish seed from the mixed riverine spawn	K.P. Srivastava, R.K. Dwivedi, N.K. Srivastava, R. K. Tyagi and Ravish Chandra
-do-	-do-	Impact of Calcutta metropolitan effluent on the ecology of Kulti estuary	R.K. Banerjee, A.C. Nandy, H.C. Joshi and B.B. Das
-do-	-do-	The magnitude of affliction on fish and its environment vis-a-vis industrial discharge in the Hooghly estuary	R.K. Das, M.M. Bagchi, M.K. Mukhopadhyay, B.B. Ghosh and Keya Saha

1	2	3	4
National Seminar on Management of Fisheries in Inland Open Water System of India (14-16 December 1988)	Jointly organised by Central Inland Capture Fisheries Research Institute (CICFRI) and Inland Fisheries Society of India, Barrackpore	Studies on thermal and chemical stratifications of Govindsagar reservoir, Himachal Pradesh	H.P. Singh
-do-	-do-	Fish Marketing efficiency - a case study of Allahabad (U.P.)	Pradeep K. Katiha and Ravish Chandra
-do-	-do-	Impact of stocking of advanced fingerlings on the fish yield from Aliyar reservoir	C. Selvaraj, V.K. Murugesan & P.K. Aravindakshan
-do-	-do-	Role of ecological parameters in fisheries management of a newly impounded reservoir - Bachhra reservoir	M.A. Khan, S.N. Mehrotra, K.P. Srivastava, D.N. Singh & R.K. Tyagi
-do	-do-	Observations on low electrolyte reservoir water on carp egg hatching and survival rate	K.O. Joseph, C. Selvaraj, V.K. Murugesan, P.K. Aravindakshan
-do-	-do-	Fishery Resources and fishing trends in the upper and the middle stretches of the Hooghly estuarine system in recent years	B.N. Saigal, P.M. Mitra & H.C. Karmakar

1	2	3	4
National Seminar on Management of Fisheries in Inland Open Water System of India (14-16 December 1988)	Jointly organised by Central Inland Capture Fisheries Research Institute (CICFRI) and Inland Fisheries Society of India, Barrackpore	The open water fisheries in the lakes of Indian botanical garden	Maya Chakraborty, D.N. Guha Bakshi, S.K. Basu and K.R. Naskar
-do-	-do-	Studies on some fish poisonous plants in the open water system	Kumud Ranjan Naskar and N.N. Mazumdar
-do-	-do-	Potential of pen culture in ox-bow lake	S.P. Rai and R.C. Singh
-do-	-do-	Oil pollution in the Hooghly estuary between Nayasarai and Haldia and the related toxicity to fish, prawn and zooplankters	B.B. Ghosh and M.M. Bagchi
-do-	-do-	Angling catch returns as indicators of the status of fisheries in Powai lake	M.J. Bhagat and S.N. Dwivedi
National Symposium on Aquaculture Productivity (16-17 December 1988)	Hindustan Lever Research Foundation, Bombay	Fisheries status of aquaculture-based open water systems of India	Arun G. Jhingran

1	2	3	4
13th National Seminar of the IASLIC (20-23 December 1988)	Bengal Library Association, Calcutta		Mrs. A. De and F. Manna
48th Annual Conference of Indian Society of Agricultural Economics (27-29 December 1989)	Benaras Hindu University, Varanasi	Institutional credit for aquaculture	P.K. Katiha and Anand Swarup
Symposium on Recent Outbreak of Fish Diseases in North East India (30 December 1988)	Zoological Society, Assam, Cotton College, Guwahati	Impact of disease on fishing communities - A case study in Siligurijan Beel, Dist. Kamrup, Assam (India)	Y.S. Yadava
Symposium on Chhatrisgarh Agricultural Systems - Accomplishments, present status and future strategies (20-23 January 1989)	Indira Gandhi Agricultural University, Raipur, M.P.		V.R. Desai, Dhirendra Kumar & N.P. Srivastava
National Workshop on Research and Development Needs of Coldwater Fisheries at NRC (30-31 January 1989)	Haldwani	Status of Mahseer in upland waters	M.J. Bhagat
-do-	-do-	Ecology and management of Himalayan lakes	K.K. Vass

1	2	3	4
National Symposium on Nuclear Techniques in the Study of Pesticides in Food, Agricudlture and Environment (8-10 February 1989)	Hebbal	Bio-accumulation of C^{14} labelled DDT in various trophic levels of aquatic environment	Arun G. Jhingran and Babu Lal
National Seminar on Agro-Ecosystem Management (18-21 February 1989)	Visva-Bharati, Palli Siksha Bhawan (Institute of Agriculture), Sriniketan, Birbhum, West Bengal	Integration of Magur *(Clarias batrachus)* breeding technology with paddy cultivation : A boon for rural development in the tribal belt of Chhotanagpur Division (South Bihar)	Dhirendra Kumar
All India Seminar on Wetland Resources and Management (24 February 1989)	Institution of Engineers (India), Calcutta	Present status, problem and prospect of wetland resources in North-Eastern India	Y.S. Yadava
Seminar on Aquacultural Engineering Education in India (16-17 March 1989)	I.I.T., Kharagpur	Appropriate design of cage - a prerequisite for higher fish yield in open waters	A.B. Mukherjee
-do-	-do-	Intensive culture of tiger shrimp *P. monodon* using balanced feed	Apurba Ghosh, Ansuman Hajra, Motilal Bhowmik, R.K. Chakrabsorti and P.K. Chakraborti

VISITORS

A large number of distinguished personalities including national leaders visited the Institute's Headquarters and its different centres during 1988-89. They include Hon'ble Union Minister of State for Agricultural Research & Education, Govt. of India, **Shri Hari Krishna Shastri** and Hon'ble Minister for Technical Education and Fisheries, Govt. of Haryana,**Shri Laxmi Narayan Rao.** The following is the list ofotherdistinguishedvisitors:

Ahmed, E. (Dr.), Reader in Zoology, Bihar University, Muzaffarpur

Ahmed, Saleh Uddin, Deputy Director, Fisheries Research Institute, Riverine Station, Candpur, Bangladesh

Arthur, J. Richard (Dr.), IDRC, Singapore

Banda, K.P., Aquaculturist, Zambia

Bandopadhyay, P. (Prof.), Institute of Radio Physics & EL, Calcutta University

Baruah, M., Deputy Director of Fisheries, Govt. of Assam

Bhattacharya, Samir (Dr.), Dept. of Zoology, Visva-Bharati University, Santiniketran

Boonyartpalin, Mali (Dr.), National Inland Fisheries Institute, Bangkok, Thailand

Bora, P.C. (Dr.), Vice Chancellor, Assam Agricultural University, Jorhat

Bose , A. N. (Dr.) ,Ex. Vice Chancellor , Jadavpur University

Bose, Prasanta Kr., Sr. Reporter, Amrita Bazar Patrika, Calcutta

Bose, S.K. (Dr.), Prof. of Zoology, Ranchi University, Ranchi

Chandrashakharaiah, H.N., Joint Director of Fisheries, Karnataka

Chopra, C.(Smt.), Secretary(Fisheries), Govt. of Rajasthan, Jaipur

Chen Foo Yan (Mr.), Coordinator, Network of Aquaculture Centres in Asia, UNDP, GPO 618, Bangkok

Das, P. (Dr.), Director, NBFGR, Allahabad

Dasgupta, A.B., Member, West Bengal State Planning Board, Calcutta

De Sarkar, Ranajit, Programme Executive, DDK, Calcutta

de Silva Sena S , (Prof.), IDRC, Singapore

Dehadrai, P.V. (Dr.), Deputy Director General (Fisheries), Indian Council of Agricultural Research, Krishi Bhavan, New Delhi

Dutta, A (Dr.), Reader, Dept. of Zoology, Guwahati University, Guwahati

Datta Naresh (Prof.) , Department of Zoology ,University of Calcutta

Gopalakrishnan, C.N., Addl. Director of Fisheries, Kerala

Jhingran, V.G. (Dr.), Ex-Director, Central Inland Fisheries Research Institute, Barrackpore

Johri V. K , Director of Fisheries ,Uttar Pradesh, Lucknow

Kalawar, A.G. Retd. Director of Fisheries, Govt. of Maharashtra

Kamal, M.Y. (Dr.), Assistant Director General (Fisheries), Indian Council of Agricultural Research, Krishi Bhavan, New Delhi

Kee Chai Chong (Dr.), Economist (Aquaculture), NACA, Bangkok

Konar, S.K. (Prof.), Fisheries Laboratory, Dept. of Zoology, Kalyani University, Kalyani

Kundra, A.K., Secretary, Fisheries Department, Govt. of Punjab

Luu, Le-Thanh (Dr.), Head, Applied Biology, Research Institute of Aquaculture No.1, Vietnam (RIA No.1)

Maguswi, C.T., Biologist, Zambia

Mahapatra, C.R., Deputy Secretary, Indian Council of Agricultural Research, Krishi Bhavan, New Delhi

Manna, G.K. (Prof.), Kalyani University, Kalyani

Mehta, V.S. (Dr.), Head, Dept. of Soil and Agricultural Chemistry, R.B.S. Post-Graduate College, Bichpur, Agra

Menon, A.G.K. (Dr.), Ex-Deputy Director, Zoological Survey of India, Calcutta

Menon, M.G.K. (Dr.), Scientific Adviser to Prime Minister & Member, Planning Commission, New Delhi

Michael, R.G. (Dr.), Prof. of Zoology, NEHU, Shillong

Mullick, S.K. (Dr.), Reader of Zoology, Bihar University, Muzaffarpur

Natarajan, C. (Dr.), Director, Bio-Technology, Dept. of Science & Technology, New Delhi

Noor, M.N. (Dr.), Prof. of Botany, Ranchi University, Ranchi

Pandey, S.N. (Dr.), Director, JTRL, Calcutta

Pathak, S.C. (Dr.), Manager (T), NBARD, Bombay

Pillay, T.V.R. (Dr.), 74, Via : Eupoli, Catalpaloceo, Rome, ITALY

Pampapathi, M., Fisheries Development Officer, Tamil Nadu

Prasad, P.S. (Dr.), Director of Fisheries, Govt. of Bihar

Prasad, R., Deputy Director of Fisheries, Agra

Rama Rao,Y. (Dr.), Adviser (Fisheries), North Eastern Council, Shillong

Sadaphal, M.N. (Dr.), Assistant Director General (CDN), Indian Council of Agricultural Research, Krishi Bhavan, New Delhi

Saikia, J., Chairman, AFDC, Guwahati

Sarma, K., Dean, Faculty of Law, Guwahati University, Guwahati

Sharma, Manju (Mrs.), Chief Science & Scientific Secretary, Planning Commission, New Delhi

Shukla, J.P. , Dy Director of Fisheries, Govt. of Rajasthan

Singh, S.P. (Dr.), Prof. of Zoology, Magadh University, Gaya

Singh, B.R. (Dr.), Prof. & Head, Zoology Dept., Bihar University, Muzaffarpur

Singh, S., Reader of Zoology, Bihar University, Muzaffarpur

Singhal, S.C., American Soyabean Association, New Delhi

Singhla, B.L., Director of Fisheries, Govt. of Punjab

Sinha, J.P. (Dr.), Ex-Prof. and Head of Botany, Ranchi University, Ranchi

Sinha, M.R. (Dr.), Advisor (Fisheries), North East Council, Shillong

Srivastava, O.P. (Dr.), Prof. & Head, Department of Soil and Agricultural Chemistry, Benaras Hindu University, Varanasi

Srivastava, U.S. (Prof.), Ex-Head of Dept. of Zoology, Allahabad University, Allahabad

Thakur, R.N. (Dr.), Head, Zoology Department, Tirhut College, Muzaffarpur

Thao Nguyen-Xuan, Head, Agriculture, Fishery & Forestry, State Planning Commission, Hee, Hanoy, Vietnam

Tuong Pham-Manh, Director, Research Institute of Aquaculture No.1, Tienson-Habac-Vietnam

Tripathi S . D. (Dr.) , Director , CIFA , Dhauli, Bhubaneswar

Tripathi, S.R. (Dr.), Prof., Gorakhpur University

Tripathi, Y.R. (Dr.), Ex-Director of Fisheries, Govt. of Uttar Pradesh, Lucknow

Tyagi, R.P.S. (Dr.), Member, Agricultural Scientists Recruitment Board, New Delhi

Ung Thai doan ,Research Institute of Aquaculture No. I , Vietnam

Upadhyaya, S.N., Project Officer, AFC, Guwahati

Venema, C. Siebren (Dr.), Project Manager, FAO/UNDP Project, Marine Resource Service, Fishery Resources & Environment Division, FAO, Rome ITALY

Verma, B.N. (Dr.), Reader of Botany, Bihar University, Muzaffarpur

Vernam, R.B., Department of Fisheries, Agra.

FINANCE

For the year 1988-89

(Rs. in lakhs)

		B.E. 1988-89 (Rs.)	R.E. 1988-89 (Rs.)	Actual Expenditure 1988-89 (Rs.)
Plan	:	100.00	70.00	76.21
Non-Plan	:	145.00	155.00	158.08
Total	:	**245.00**	**225.00**	**234.29**

CENTRE-WISE LIST OF ONGOING PROJECTS 1988-89

BARRACKPORE	FC/A/4 BF/B/3 AN/A/9	FC/A/6 BF/B/8 CSS-1	FC/A/13 BF/A/2	BF/B/2 AN/A/7
AGRA	FC/B/10			
ALLAHABAD	FC/B/7	FC/A/14		
BANGALORE	FC/A/7	FC/A/12		
BHAGALPUR	FC/B/7			
BILASPUR	FC/A/7			
CALCUTTA	BF/B/2			
COIMBATORE	FC/A/10			
CANNING	BF/B/3			
DIAMOND-HARBOUR	BF/B/3	BF/A/2		
DIGHA	BF/B/3	BF/A/2		
ELURU	FC/B/5			
GUWAHATI	FC/B/9	FC/A/16		
LALGOLA	FC/B/7			
PATNA	FC/B/7	FC/A/15		
POLLACHI	FC/A/10			
PUNE	FC/A/7			

RAIDIGHI	BF/B/3
RAIPUR	FC/A/7
ULUBERIA	BF/B/3
VADODARA	BF/B/9

Research project merged during 1988-89

1.	AN/A/10 :	Model studies on the design of fish passage facilities in large hydraulic structures	Merged with BF/A/2

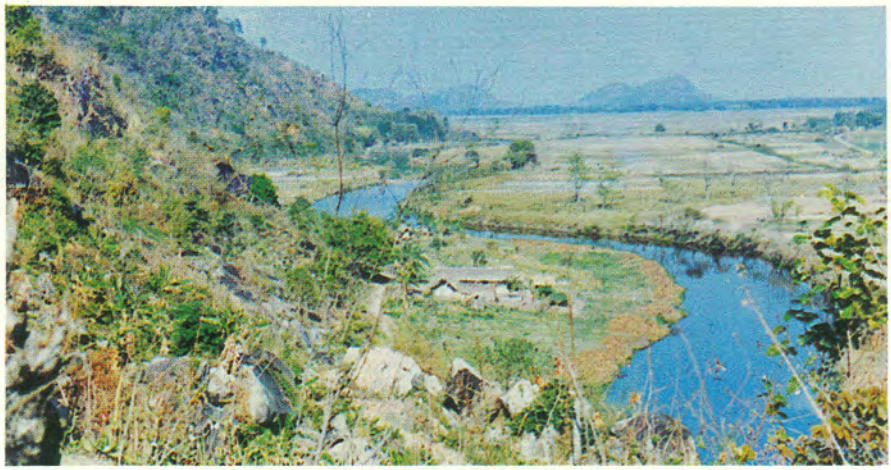
Research projects completed during 1987-88

1. FC/A/2 : Ecology and fishery management of a small reservoir in Ganga basin
2. FC/A/3 : Ecology and fisheries management of Dhir Beel in Assam
3. FC/A/5 : Ecology and fisheries management of ox-bow lakes (maun) in Gandak basin (North Bihar)

EXTENSION AND TRAINING

Women's Day : Involvement of women in fishery activities forms an important programme of the Extension wing. In the pictures above and below, the women are given training in fish farming.

Under the women's training programme in farming, saplings are being distributed at Namkhana area of South 24 Parganas.



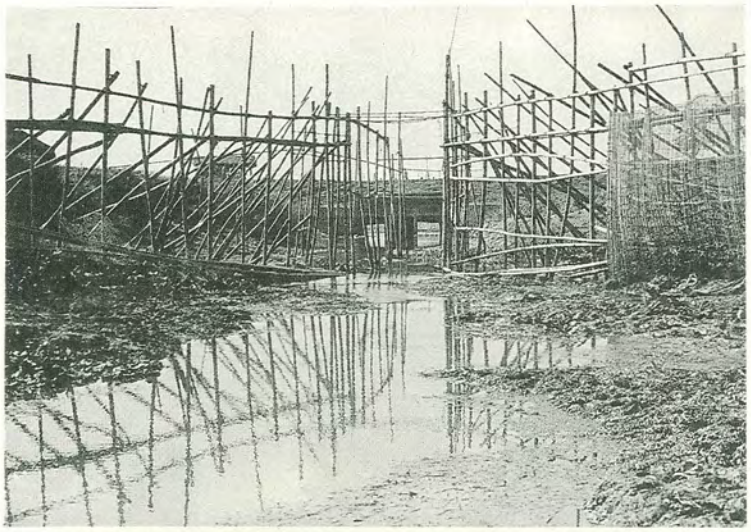
Siligurijan Beel

A close view of the beel

The flood control embankment and the River Brahmaputra in the background

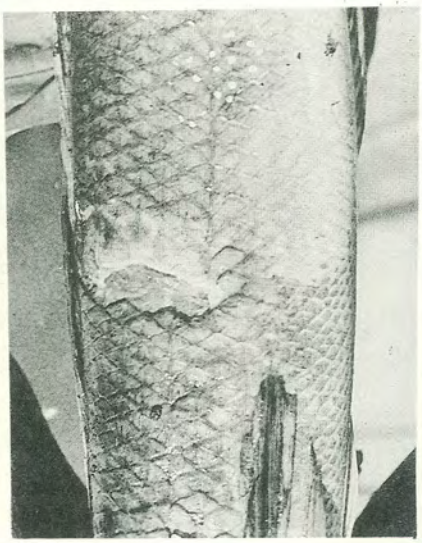
Penculture of carps in Garapota beel of West Bengal

A haul of carp from the pen after 190 days of rearing



Set barrier 'Banas' erected to prevent escapement. The sluice gate is in the background

A rich haul of *Wallago attu* from Siligurijan Beel



E.U.S. outbreak in Siligurijan Beel

ONGOING PROJECTS

PROJECT **FC/B/5**

STUDIES ON THE ECOLOGY AND FISHERIES OF KOLLERU ECOSYSTEM AND DEVELOPMENT OF SUITABLE MANAGEMENT MEASURES FOR OBTAINING SUSTAINED FISH PRODUCTION

Personnel : Ch. Gopalakrishnayya, R.S. Panwar, K.V. Rao, M. Ramakrishniah, J.B.Rao, T.S. Rama Raju, K.S. Rao, P.S.C. Bose, C.G. Rao and S. Kotaiah

Duration : 1987-1991

Location : Kolleru Lake Fisheries Research Centre of Central Inland Capture Fisheries Research Institute, Eluru-534 002

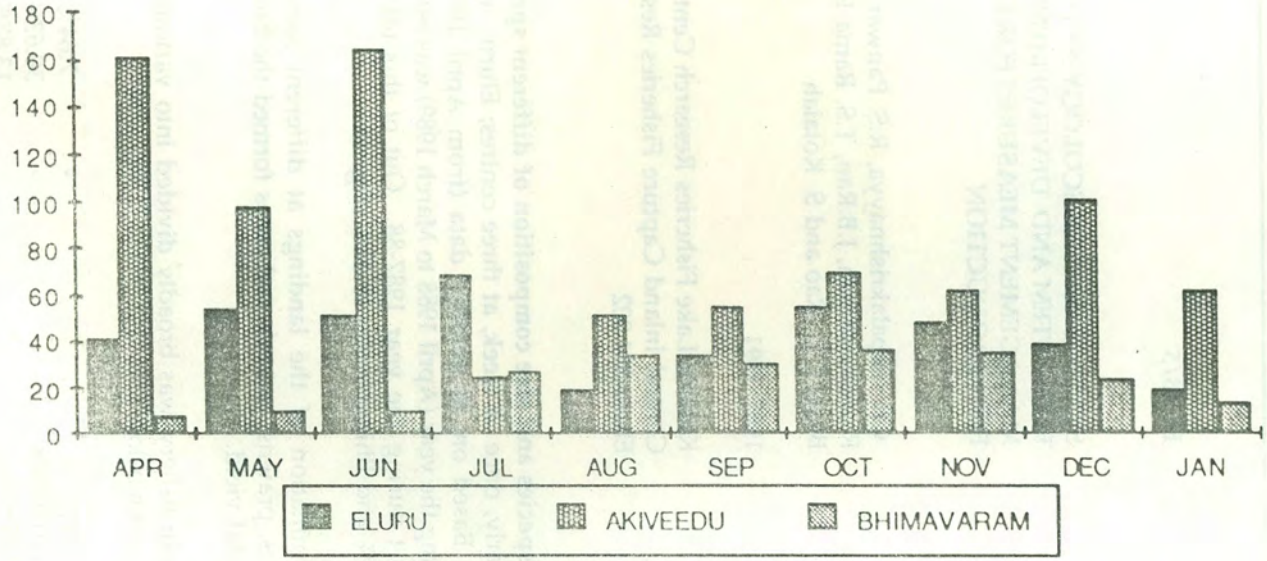
Catch, species and size composition of different species : Fish landing data were collected regularly, once a week, at three centres; Eluru, Akiveedu and Bhimavaram on Kolleru Lake. Based on 10 months' data (from April 1988 to January 1989), the fish production during the year (April 1988 to March 1989) was estimated to be 1813.73 tonnes as against 1861.43 t during the year 1987-88. Out of this total, Eluru contributed 28.21%, Akiveedu 56.52% and Bhimavaram 15.27% (Fig. 1).

An examination of the landings at different sampling centres revealed that catfishes, perches, prawns, murrels and carps formed the bulk in the fishery, contributing 95.53% to the total yield.

The whole fishery was broadly divided into various groups and the group-wise percentages are given below :

Carps	-	7.64%
Catfishes	-	30.63%
Murrels	-	13.87%
Perches	-	28.70%

FIG. I CENTRE-WISE PRODUCTION (IN T) IN KOLLERU LAKE FROM APRIL 1988 - JANUARY 1989



Prawns	-	14.69%
Miscellaneous	-	4.47%
Anabas oligolepis	-	27.70%
Heteropneustes fossilis	-	23.05%
Metapenaeus monoceros	-	11.79%
Channa striatus	-	10.07%
Mystus gulio	-	4.31%
Labeo rohita	-	3.81%
Channa punctatus	-	3.16%
Wallago attu	-	2.12%
Cirrhinus mrigala	-	1.40%
Catla catla	-	1.40%

Bhimavaram centre was responsible for higher landings of prawns followed by Akiveedu. Prawn landings were minimum at Eluru. Total fish and prawn exported during the year was estimated to be 1768.29 t as against 1544.10 t during the preceding year thus registering a rise of 14.52%. Maximum quantity of fish (36.21%) was exported in iced condition (Fig. 2).

Plankton : Observation on diurnal variation of plankton in Kolleru Lake showed extremely poor production ranging from trace to 0.1 ml 50 l^{-1} of water filtered excepting in few instances of slightly higher production of 0.3 ml (June) and 0.16 ml (July) at Tadinada Centre and 0.4 ml (July) at Chinayedlagadi and 0.2 ml (June) at Polraj drain per 50.1. Plankters varied from one to 59 u l^{-1}. There is no significant difference in the production of plankton when compared to previous year.

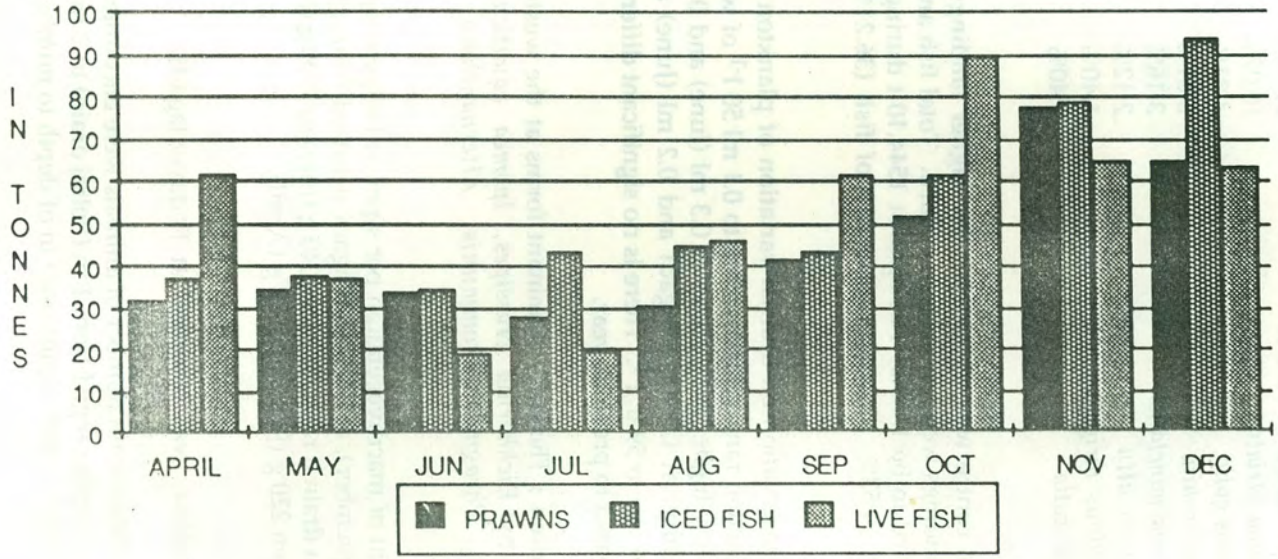
Macrovegetation : The most dominant forms at the western part of Kolleru Lake were represented by *Eichhornia crassipes, Ipomea aquatica, Nymphea alismoides, Cyperus platystylis, Phragmatis communis, Alternanthera sessiles* and *Scirpus articulatum.*

The net weight of macrovegetation per sq.m. at Pedayedlagadi ranged from 1900 g (April) to 6105 g (September), at Chinayedlagadi it varied from 2350 g (August) to 7900 g (December), at Polraju drain it ranged from 1040 g (July) to 7700 g (November & May) and at Tadinada it varied from 220 g (June) to 6609 g (April).

Hydrilla verticillata was recorded at Pedayedlagadi.

Bottom Biota : Maximum number of animals were encountered only in August in all the 3 centres where the depth ranged from 1 m (Polraj drain) to 2 m (Pedayedlagadi) during this month. There was no marked significance in of depth to number relationship.

FIG. 2 COMPOSITION OF LIVE FISH, ICED FISH AND PRAWNS AMONG THE CATCH FROM KOLLERU LAKE - 1988-89



	Depth range (cm)	Number sq.m.
Pedayedlagadi	95-175	117-1560
Chinayedlagadi	65-200	195-546
Polraju drain	50-200	273-897

Gastropods contributed maximum to the production at all the centres except in August, September and May. The species encountered were *Tubefix, Aelosoma and Branchiobdella* (oligochaetes), *Pleurocera, Vivipara, Goniobasis, Gyrulus, Helisoma, Buillinous* and *Lemnea* (Gastropods), *Sphaerium and Pisidium (Bivalves).*

Upputeru drain is subjected to tidal effect and the consequent constant variation in depth in a narrow range. Animals in this zone ranged from 273 u m^{-2}. (July) to 780 u m^{-2}. (May) where the depth varied from 2 m to 2.5 m.

Physico-chemical features of soil, water and primary productivity : The discharge of untreated sewage waste and industrial effluents along with infestation of aquatic vegetation into peripheral regions of the lake create nutrient loading problem, especially during summer months. The severe pollutional effect was noticed when depletion of dissoslved oxygen was nil to 1.50 mg l^{-1} with high concentration of CO_2 (34.0 mg l^{-1}) at Pedayedlagadi centre, followed by Chinayedlagadi (D.O., nil to 2.0 mg l^{-1}, CO_2, 26.0 mg l^{-1}. The pH of the water was recorded to vary from 7.0 to 8.4.

The difference between the morning and noon air and water temperatures was less in August (air temperature - 2.0°C to 4.5°C, water temperature 0 - 1.1°C, and more in May (air temperature - 6.0°C water temperature 2.5°C to 7.5°C).

The water did not show any remarkable six and twelve hourly change in chemical condition but its productivity which was low (15.1 to 18.75 mg C m^{-3} h^{-1}) in monsoon season (August & September) at Tadinada was moderate in April (58.33 mg C m^{-3} h^{-1}). The pH of the water was always alkaline, ranging from 7.5 to 8.4.

The free CO_2 which was high during April (20-28 mg l^{-1}) and July (16-30 mg l^{-1}), was low (2.0 to 4.8 mg l^{-1}) during November 1988 and January 1989. Dissolved oxygen was found low (0.44-3.8 mg l^{-1}) upto September but moderate (4.56) to high (7.0 mg l^{-1}) during November. Other physicochemical conditions of water were characterised by bicarbonate alkalinity 160-260 mg l^{-1} and hardness 120-180 mg l^{-1}. The primary productivity ranged

from 12.50 to 58.33 mg C m^{-3} h^{-1} and 4.13 to 22.04 mg C m^{-3} h^{-1} during day time and nil to 17.71 mg C m^{-3} h^{-1} during night time.

Biological investigations of commercial fish and prawn :

Major carps : Fishery of major carps mainly pertained to 1 year group and almost all carps were removed from the lake with the help of traps every year during premonsoon and postmonsoon months.

Catfishes : *M. gulio* had a prolonged breeding season. The fish mainly fed on gastropods followed by fishes and insects.

Anabas oligolepis : The sex-ratio was in favour of females (1 : 3) during breeding season, which was restricted to June-August period with peak in July. The fish is an omnivore.

It is the most dominant species in the commercial catches. The fishery is mainly contributed by 0-I year age group (95-135 m). Recruitment to the fishery occurred at a length of 80 mm during October.

A. testudineus : It occurred significantly only during May to July. Its breeding season coincides with that of *A. oligolepis*. Fecundity ranged from 3540 (95 mm) to 69,000 (196 mm).

Channa striatus : It is the dominant species among murrels contributing to commercial catches. Breeding commences during premonsoon months (April) and extends to the end of monsoon (September).

C. punctatus : It is numerically dominant among murrels. Bulk of the catches are contributed by the size group 100-200 mm. A 41 gram oozing fish (150 mm) yielded 6,500 eggs.

The food consisted of miscellaneous species of fish like, *P. sophore, G. giuris, L. thermalis* and *A. mola.*

Fish and shell fish fauna

Fifteen species of fish belonging to 12 families, recorded from Kolleru and Upputeru, during the year were added to the list of 90 species recorded earlier. The species are : *Pisodonophis boro, Moringua raitaborua, Zenarchopterus disper, Arius caelatus, A. arius, Pseudeutropius taakree, Otolithus maculatus, Johnius coitor, Nibea sp., Ambassis gymnocephalus, Dendrophysa russelli, Lutjanus sp., Thryssa purava, Pellone ditchela* and *Gerres filamentosus.*

PROJECT **FC/B/7**

INVESTIGATIONS ON FACTORS RELATING TO DECLINE IN FISHERY OF RIVERS GANGA AND YAMUNA

Personnel :

Ravish Chandra, S.K. Mukhopadhyay, S.K. Wishard, D.N. Singh, R.K. Saxena, Balbir Singh, H.P. Singh, G.N. Srivastava, M.A. Khan, R.K. Dwivedi, R.K. Tyagi, K.P. Srivastava, V.R. Chitranshi, D. Kumar, V. Pathak, A.K. Lal, P.K. Katiha, A.R. Chaudhury, B.C. Jha, S.K. Sarkar, B.L. Pandey, P.N. Jaitly, N.K. Srivastava, Ram Chandra, D.N. Srivastava, K.S. Banerjee, J.P. Misra, Bhai Lal, A. Sarkar, K.P. Singh, R.C. Singh, M.P. Singh, S.K. Srivastava.

Duration: July 1986-1991

Location: Riverine Division, Allahabad/Patna/Bhagalpur/Lalgola Research Centres

Population structure, breeding biology and recruitment of *Tenualosa ilisha* :

The estimated total landings of hilsa at Allahabad during the period April-December 1988 were 1149.30 kg constituting only 1.3% to the total catch. This was 586.42 kg less than what was recorded during the same period last year. Maximum catch (310.44 kg) was recorded in October as in the previous year (Table 1). Progressive landings of hilsa from 1984 onwards suffered a great set back during this year probably due to severe allround drought conditions in 1987. All sizes were represented in the catches but the II year group dominated followed by the III year group.

Table 1. Month-wise landings of hilsa in kg during the years 1986-88 at Allahabad

Months	1986	1987	1988
April	21.50	5.63	0.00
May	0.00	0.00	11.47
June	0.00	0.00	15.90
July	0.00	3.69	9.05
August	0.00	20.38	0.00

September	140.79	419.28	200.44
October	1702.68	1250.94	585.44
November	1.50	188.85	228.19
December	88.60	54.85	98.81
Total :	1955.07	1943.02	1149.30

Very few fingerlings (87-172 mm) were recorded from River Yamuna in April indicating poor late monsoon recruitment. As compared to last year, the availability of hilsa larvae was very poor. Only 190 larvae, 171 with yolk sac, were reported from Sindhoraghat in September and a few stray specimens from Sirsaghat in October.

At Patna, the landings of hilsa improved during this year (110 kg) constituting 0.2% of the total catch, when in 1986 and 1987 hilsa was not represented in the commercial catches. Juveniles, in the size range of 110-140 mm and adults in 375-410 mm were recorded during the period under report.

Hilsa landings at Bhagalpur and Lalgola were estimated to be 2200 kg and 7020 kg respectively. The II year class were more abundant (55.06%) in landings. Spawn were available at Kuaghat (Colgong). In April-May juveniles, measuring 70-165 mm, were caught indicating successful spawning of hilsa in the upper reaches.

Estimation of biological and population parameters of commercially important fish species

Fish landings at Sadiapur, Daraganj, Patna, Bhagalpur and Lalgola centres were estimated at 70.04, 22.12, 55.76, 50.23 and 44.72 t respectively during March-December 1988. The species-wise breakup is given in Table 2.

In comparison to the landings for the corresponding period of the preceding year, Sadiapur and Daraganj registered a decline (19.5% & 21%). At Patna, the fishery showed an overall decline of 10.4% over that of the last year the mainly noticed in the landings of miscellaneous group fishery. The fish landings registered an increase of 23.4% at Bhagalpur. Lalgola landings showed a decrease of 66% over the landings of the preceding year. At Bhagalpur, increase in major carps and miscellaneous group of fishes were noticed whereas all the species declined at Lalgola.

Juvenile fishery

In spite of good rains in 1988, the juvenile fishery, which used to form the bulk of catches during post-monsoon season throughout the stretch, was of very low order (0.05 t at Allahabad, 0.12 t at Patna and 3.02 t at Bhagalpur).

TABLE - 2. FISH LANDING AT DIFFERENT CENTRES (in tonnes)

Species	Centres				
	Sadiapur	Daraganj	Patna*	Bhagalpur	Lalgola
C. mrigala	3.05 (4.4)	0.48 (2.2)	3.69 (5.6)	0.85 (1.7)	0.34 (0.8)
C. catla	2.17 (3.1)	0.09 (0.4)	3.89 (5.9)	3.27 (6.5)	0.86 (1.9)
L. rohita	2.11 (3.0)	0.09 (0.4)	1.42 (2.2)	1.16 (2.3)	0.32 (0.7)
L. calbasu	7.54 (10.8)	0.98 (4.4)	1.04 (1.6)	0.10 (0.2)	0.55 (1.2)
Total of major carps	**14.87**	**1.64**	**10.04**	**5.38**	**2.07**
M. aor	7.24 (10.3)	1.09 (4.9)	9.25 (14.1)	1.43 (2.8)	3.29 (7.4)
M. seenghala	7.50 (10.7)	2.12 (9.6)	7.06 (10.7)	1.14 (2.4)	0.49 (1.1)
W. attu	1.33 (1.9)	0.83 (3.,8)	3.89 (5.9)	12.04 (23.9)	2.58 (5.8)
Total selected catfishes	**16.07**	**4.04**	**20.20**	**14.61**	**6.36**
Hilsa	0.92 (1.3)	0.18 (0.8)	0.11 (0.2)	0.22 (0.4)	7.02 (15.7)
Others	38.18 (54.5)	16.26 (73.5)	35.30 (53.8)	30.02 (59.8)	29.27 (65.4)
Total :	**70.04**	**22.12**	**65.65**	**50.23**	**44.72**

(Figures in brackets indicate % in total)

* January 1988 - December 1988

At Allahabad the mean length of commercial species for 1987 and 1988 are given in Table 3.

Table 3. Mean length of fishes at Allahabad

Species	Mean length (mm) 1987	1988
C. mrigala	623	558
C. catla	735	618
L. rohita	650	580
L. calbasu	472	451
M. aor	447	438
M. seenghala	545	488
W. attu	544	471
T. ilisha	396	347

For catch per unit of effort studies eight points, two at Allahabad, four at Patna and two at Bhagalpur were taken up. The gear-wise estimated catch per boat is given in Table 4.

Biological investigations

Allahabad

Biological studies of *M. aor, M. seenghala, C. catla* and *L. rohita* were taken up in the month of October 1988. Selected morphometric characters were recorded.

TABLE-4. GEAR-WISE AVERAGE CATCH PER BOAT (Kg)

Centre	Gear						
	Gill net	Drag net	Cast net	Scoop net	Trap net	Spear	Hook & line
Allahabad							
i) Bakahshimodha (Yamuna)	3.35	23.50	-	2.36	-	-	2.85
ii) Lavain (Ganga)	3.80	19.75	-	-	-	2.45	-
Patna							
i) Alamganj (Ganga)	2.56	-	5.90	-	1.31	-	4.40
ii) Ghoghaghat (")	5.60	12.00	4.50	-	2.50	-	3.00
iii) Mahendrughat (")	6.21	7.60	-	-	-	-	2.75
iv) Ranighat (")	6.00	4.24	2.50	-	-	-	-
Bhagalpur							
i) Hanumanghat (River Ganga)	-	16.23	-	-	-	-	-
ii) Adampurghat (River Ganga)	-	28.63	73.3	-	0.50	-	-

The length frequency data for *M. aor* and *M. seenghala* collected during the past from Sadiapur fish landing centre were analysed for the estimation of population parameters and the results are as follows :

	Total mortality	Fishing mortality	L	K	MSY
M. aor	0.68	0.34	1360	0.16	13.95
M. seenghala	0.61	0.38	1420	0.10	13.08

Studies on breeding and recruitment of selected commercial and non-commercial fishes

To study the spatio-temporal variations in the availability of spawn/fry/fingerlings of major carps, investigations were conducted on River Yamuna at Manduka and on River Ganga at Chilla.

Manduka Centre

During 47 days' observation, commencing from 5th July, the river experienced five floods. A total of 6095 ml of spawn was collected by operating five numbers of shooting nets as against 400 ml of spawn collected in the previous year. The maximum catch/net/hour was estimated to be about 15 ml. The average percentage of major carp was 35%, while minor carp and others constituted 65%. The percentage of desirable spawn in different spurts i.e. from 1st to Vth was estimated at 9.8, 28.6, 57.2, 51.2 and 27.0 respectively. Seasonal indices of quantity and quality were estimated to be 6099 ml and 53%, respectively. Nursery and plastic pool rearing indicated the percentage of major carp to be 53% constituting *C. mrigala* (21.3%), *C. catla* (16.2%), *L. rohita* (13.2%) and *L. calbasu* (2.2%). The major carps, mainly represented by *L. bata* and *C. reba*, constituted 47%.

Hydrological parameters were also studied simultaneously. Current velocity and turbidity values during the spawn availability period fluctuated between 0.30 to 1.5 km/hr and 300 to 1200 ppm respectively.

Chillaghat

The investigations lasted for 47 days from 5th July to 20th August 1988. During this period the river experienced four floods. The spawn was available in one spurt during the 1st flood when a total of 200 ml spawn was collected using five standard shooting nets in the availability period. About 5000 major carp fry were also collected. The microscopic analysis of spawn revealed that the average percentage of desirable spawn was 21.6. The percentage of major carp, as estimated on rearing, was found to be 45.5 comprising *C. mrigala* (30.5%), *L. rohita* (12.5%) and *L. calbasu* (3.5%).

The fry collected during the IIIrd and IVth flood showed the percentage of major carps to be 52.5%, comprising *C. mrigala* - 30.5%, *L. rohita* - 16.5% and *L. calbasu* - 5.5%.

A stretch of River Ganga from Allahabad to Varanasi was surveyed and 17 deep pools (20 to 40 metres deep) were located. The deepest pools were found at Chunarghat and Narayanpur.

A 120 km long stretch of River Yamuna, from Rajapur to Allahabad, was surveyed, and the following deep pools were charted by enquiry (Table 5).

Table 5. List of deep pools located

Name of the village	Approx. length in (km)	Approx. depth in metre
1. Khanjasa	0.5	30-40
2. Pratap Pur	1.0	40-50
3. Mau	2.0	60-80
4. Barwar	1.0	40-50
5. Katri	0.5	30-40
6. Rajapur	1.0	50-60

Further down on the River Ganga, from Allahabad to Varanasi, the following deep pools were charted :

7. Manda Mukundpur	0.5	20-30
8. Jera	1.0	20-40
9. Chakhata ghat	1.0	20-30
10. Nawar	1.0	50-60
11. Umapur to Baruka	2.0	20-30
12. Bhairupur ghat	0.50	20-30
13. Gogaun	0.50	20-30

14.	Khavia	0.15	20-30
15.	Pepra Dah	1.0	20-40
16.	Chandika	1.0	20-50
17.	Tekaur	1.0	30-50
18.	Chunar ghat	0.5	20-40
19.	Raipuriya	0.5	25-35
20.	Narayanpur	0.5	25-40
21.	Ghhoti Mirzapur	0.5	20-30
22.	Garhwa ghat	0.5	25-40
23.	Assighat to Rajghat	5.0	20-50

River Ganga was surveyed in and around Patna and only one deep pool was located, near Sherpur. Near Bhagalpur, the following five deep pools were located :

1. Narainpur
2. Ghogra
3. Titahi
4. Kahalgaon
5. Ekehari

Most of these deep pools harbour all varieties of fish and during summer they serve as refuge. Fishermen mostly operate gill nets in these stretches.

A total of 76.2 ml of spawn was collected at Sherpur (near Patna), showing a decline of 54.0% over the last year. It comprised major carps (12.4%), minor carps (54.0%), catfishes (10.5%) and prawns (23.0%).

Impact of environmental changes on the biotic communities

Studies were undertaken to evaluate the environmental factors responsible for decline of fishery in Rivers Ganga and Yamuna around Kanpur, Allahabad, Varanasi, Patna and Bhagalpur.

Characterisation of polluted zones

BOD and COD at Kanpur, Varanasi and Allahabad

The monthly production of BOD was high at the outfall (OF) at all the centres (Table 6). The highest recorded values were 608 mg l^{-1} and 592 mg l^{-1} at the sewage

TABLE - 6. MONTHLY RANGES IN BOD (mg l^{-1}) AT DIFFERENT STATIONS ON RIVER GANGA AND YAMUNA IN 1988

Month	Kanpur			Allahabad			Varanasi	
	Bhagwatignat	Jajmau	Tannery	Mehdauri	Mavaiya	Kakarahaghat	Basanta	Assi/Nagewa
May	16.0-24.0	64.0-80.0	80.0-112.0	16.0-48.0	8.0-16.0	16.0-24.0	45.0-46.0	32.0-40.0
June	25.6-132.0	60.8-115.0	25.6-92.8	3.8-9.0	4.0-20.0	10.0-28.0	32.6-105.	28.0-30.0
July	-	-	-	36.0-80.0	18.0-44.8	22.0-38.4	-	-
August	30.4-416.0	256.0-608.0	256.0-400.0	16.0-144.0	10.0-152.0	8.4-78.0	160.0-592.0	104.0-266.0
September	51.2-102.4	48.0-144.4	25.6-198.4	8.8-121.0	6.8-132.0	8.6-88.8	32.0-140.8	32.0-78.8
October	-	-	-	32.6-64.0	5.8-64.0	5.8-68.0	-	-
November	31.0-110.0	36.0-126.0	39.0-166.0	16.0-88.0	20.0-92.0	12.0-98.6	21.0-132.0	16.0-81.4
December	1.6-318.0	18.0-508.0	1.6-78.4	6.4-98.4	17.2-83.2	8.0-89.6	3.0-42.6	7.6-76.8

discharge centre (Jajmau) of Kanpur and Basanta Nullah of Varanasi respectively, in August. The lowest values were observed in the freshwater zones of the centres. Freshwater zones were characterised by very low values of COD, whereas, polluted zones, especially Kanpur centres witnessed wide fluctuation (Table 7). The highest value of COD (468.00 mg l^{-1}) was recorded at the tannery OF due to the discharge of alkali wastes.

Identical conditions in respect of BOD values were witnessed at these zones during last year also.

Stretch-wise details :

Kanpur

Primary organic carbon production : The organic carbon production was measured at Bhagwatghat and Jajmau in polluted and non-polluted zones (Table 8).

Physico-chemical properties of soil : The soil texture varied from sandy to clayey both in River Ganga at Kanpur and Varanasi and Yamuna at Allahabad. The pH indicated alkaline nature of soil (7.18-8.70). Organic carbon was found very low in freshwater zone (0.068%) and very high (0.698%) in polluted zones of the river.

Physico-chemical characteristics of water : In the polluted zone, the water was characterized by its black colour at the OF and upto 1 km downstream. This was more pronounced at Bhagwatghat (Elgin Mill effluent) and Jajmau (sewage discharge). Except for DO, higher values were recorded for other parameters in September at the tannery discharge point : pH 11.03, CO_3 2000 mg l^{-1}.

In freshwater zone of Bhagwatghat (AOF), normal values were recorded in respect of physico-chemical parameters of water.

Impact of pollution on biotic communities :

Tannery waste

On an average, plankton was estimated at 587, 1884 and 1294 u l^{-1} at OF, AOF (Above outfall) and BOF (Below outfall) respectively.

The benthic population ranged from 0 to 660, 968 to 2860 and 224 to 4004 u cm^{-2} at OF, AOF and BOF respectively. Due to the effect of pollution, the planktonic and benthic populations were adversely affected at the OF. This may be attributed to low values of oxygen (1.12 ppm) and high values of carbonate (2000 ppm), pH (11.03), BOD (400 ppm) and COD (480 ppm). However, at the BOF and AOF, biotic population revived due to dilution.

TABLE - 7. MONTHLY RANGES IN COD (mg l^{-1}) AT DIFFERENT STATIONS ON RIVER GANGA AND YAMUNA IN 1988

Month	Kanpur			Allahabad		Varanasi		
	Bhagwatignat	Jajmau	Tannery	Mehdauri	Mavaiya	Kakarahaghat	Basanta	Assi/Nagewa
May	12.8-18.8	80.0-85.0	5.0-5.4	4.8-6.0	5.5-7.6	2.2-3.0	15.2-18.0	15.4-16.4
June	1.4-15.8	12.0-86.0	4.6-10.6	4.8-30.4	4.8-9.0	2.5-5.0	3.6-10.0	12.0-12.6
July	-	-	-	12.0-18.0	10.0-16.0	5.6-6.8	-	-
August	3.0-14.0	4.8-32.6	3.2-22.8	9.8-24.8	5.6-42.0	7.6-32.0	6.0-83.4	3.2-18.0
September	15.0-75.0	25.0-88.0	27.0-468.0	4.6-36.0	3.6-41.4	9.8-26.6	5.6-81.4	7.2-28.0
October	-	-	-	10.0-16.0	7.2-12.0	6.5-14.0	-	-
November	12.0-82.0	20.0-81.5	32.0-326.0	10.0-27.0	9.2-26.4	5.6-32.4	9.8-36.0	10.2-41.0
December	2.8-34.6	11.8-184.6	2.4-20.6	2.8-26.0	8.6-24.6	2.0-26.0	2.4-21.3	3.6-84.2

TABLE-8. ANNUAL RANGES OF PHYSICO-CHEMICAL FEATURES OF RIVER GANGA AT KANPUR AND VARANASI IN 1988

Parameters	Kanpur			Varanasi	
	Bhagwatighat	Jajmau	Tannery	Basantighat (Rajghat)	Assi/Nagwa
Water temp. (°C)	19.0-31.0	19.0-32.0	19.5-33.0	22.2-32.0	20.0-32.3
Transparency (cm)	10.0-35.0	3.0-38.0	6.0-32.0	5.0-26.0	10.0-32.0
pH	7.08-7.82	6.63-8.07	7.10-11.03	6.07-7.67	6.83-7.81
Free CO_2 (mg l^{-1})	Nil-30.0	Nil-15.0	Nil-12.0	Nil-30.0	Nil-18.0
Carbonate alkalinity (mg l^{-1})	Nil-20.0	Nil-20.0	Nil-2000.0	Nil-12.0	Nil-12.0
Bicarbonate alkalinity (mgl^{-1})	124.0-290.0	130.0-470.0	120.0-2140.0	134.0-514.0	120.0-428.0
Dissolved oxygen (mg l^{-1})	Nil-10.32	Nil-10.88	1.12-9.60	1.28-9.60	3.04-9.76
Specific conductivity u mhos/cm	237.0-645.0	281.0-740.0	271-1670	303.0-935.0	318.0-686.0
Total dissolved solids (mg l^{-1})	119.0-324.0	140.0-365.0	136.0-835.0	152.0-470	159.0-344.0
Nitrate (mg 1^{-1})	0.33-1.38	0.42-1.80	0.36-1.30	0.41-1.45	0.42-1.28
Phosphate (mg l^{-1})	0.32-1.36	0.38-1.84	0.39-1.22	0.38-1.46	0.42-1.30
Gross primary organic carbon production (mg C m^{-2} h^{-1})	50.0-237.5*	62.5-333.3*	-	54.1-158.3	75.0-135.7
Net organic carbon production (mg C m^{-2} hr^{-1})	16.6-193.75	16.6-216.6	-	35.4-104.1	25.0-83.3
Respiration (mg C m^{-2} h^{-1})	20.0-75.0	55.0-140.0	-	15.0-104.1	25.0-106.2

*Not detected in June at BOF at Bhagwatighat and Jajmau

Jajmau sewage pollution

The planktonic population was estimated at 1254, 1149 and 1629 u/l at OF, AOF and BOF respectively. A decrease in numerical abundance was observed this year when compared to the previous year. *Zoogloea remigera*, a bacteria of sewage zone was also recorded indicating pollution.

The benthic fauna ranged from 132 to 968 u cm^{-2}, 1140 to 14740 u cm^{-2} and 924 to 4840 u cm^{-2} at the OF, AOF and BOF. Although variation in plankton abundance was not so significant among different zones, benthic fauna was found quantitatively less abundant at the OF and more at AOF and BOF respectively. The low population at OF may be attributed to absence of oxygen and high BOD (608 ppm) load.

Bhagwatghat (industrial pollution)

On an average, plankton were estimated at 1619 u l^{-1}, 1062 u l^{-1} and 761 u l^{-1} at OF, AOF and BOF, respectively.

The benthic population was moderate (440-1672 u cm^{-2}) at OF, low in freshwater zone (AOF) (132-528 u cm^{-2}) and abundant (26840-44000 u cm^{-2}) at BOF. Insects, molluscs and annelids dominated the benthic population, being 90%, 54% and 96% at OF, AOF and BOF, respectively. The presence of molluscs (54%) and high percentage of zooplankton at BOF indicated dilution of pollutants.

It may be surmised that species diversity was more in freshwater zone in respect of plankton and benthos. The species which could tolerate and resist pollution were identified as *Oscillatoria, Melosira, Asterionella, Keratella, Brachionus* and *Difflugia* among plankters; annelids and chironomids among macrobenthos. *Pediastrum, Pleodorina* and *Oedogonium* were identified as indicators of clean water.

Variations in species composition of plankton and benthic communities were not so significant between the centres.

Organic carbon production in River Ganga

The primary production of carbon was estimated at Mehdaurighat (BOF), Fatehpurghat and Manaiya (freshwater zones). The gross and net production of carbon fluctuated between 41.6 and 225.00 mg C m^{-2} h^{-1} and 23.00 and 81.25 mg C m^{-2} h^{-1} respectively at all the centres. In general, the carbon production was of a much higher order in freshwater zone than in the BOF.

Organic production in River Yamuna

Primary production was estimated at two centres *viz.* Kakrahaghat (BOF) and Sujawan (freshwater zone). The net and gross productions varied between 12.5 and 82.8 mg C m^{-2} h^{-1} respectively (Table 9). The primary production was considerably higher in freshwater zone as compared to BOF zone except in December.

TABLE - 10. ENERGY TRANSFORMATION AND PHOTOSYNTHETIC EFFICIENCY IN RIVER GANGA AND ITS TRIBUTARIES

River Ganga	Sampling zone	Rate of energy transformation (Cal m^{-2} day^{-1})		Av. efficiency of energy transformation
Places		Range	Average	%
KANPUR				
Bhagwatghat	AOF	1918-8733	5326	0.249
	BOF	760-3300	2030	0.094
Jajmau	AOF	135-3873	2004	0.086
	BOF	663-723	693	0.034
Av. for the whole stretch		---------	2513	**0.114**
ALLAHABAD				
Fatehpurghat		118-11828	3359	0.152
Mehdauri		260-15243	4566	0.210
Manaiya		44-6281	2904	0.137
Av. for the whole stretch		--------	**3610**	**0.167**
VARANASI				
Rajapur	AOF	2821-6010	4349	0.205
(Basantanala)	BOF	--------	14710	0.657
Av. for the whole stretch		--------	**6422**	**0.296**

PATNA			
Dighabata	119-5378	2872	0.152
Rajapur	324-2934	1306	0.064
Fatuha	94-5267	1984	0.100
Hajipur	166-5778	2750	0.144
Av. for the whole stretch	--------	**2188**	**0.113**
RIVER YAMUNA (ALLAHABAD)			
Sujawan	58-4360	2023	0.10
Kakarahaghat	40-3085	1292	0.06
Average	--------	**1658**	**0.08**
RIVER PUNPUN (PATNA)			
Fatuha	891-11690	4986	0.23
RIVER GANDAK			
Hajipur	937-6868	3989	0.19

Physico-chemical characteristics of water

The various physico-chemical parameters of water are depicted in Table 9. The nutrient contents at OF were always higher than at freshwater zone of the river. On the whole, the effect of pollution around Allahabad was observed to be of low magnitude as compared to Kanpur.

Effect of pollution on biotic communities

Mehdaurighat : (Sewage pollution). Plankton population was of a very high order at OF (av. 34102 u l^{-1}) followed by BOF (8334 u l^{-1}) and AOF (510 u l^{-1}).

Benthos followed the trend of plankton in its abundance. It was maximum (308-19190 U cm^{-2}) at OF followed by BOF (88-4088 U cm^{-2}) and AOF (0-528 U cm^{-2}).

The high population of plankton and benthos at OF may be attributed to high nutrient loading into the Ganga due to decomposition of sewage. The values of phosphate and nitrate were observed to vary from 0.36 to 1.28 ppm and 0.21 to 1.30 ppm respectively.

TABLE-9. ANNUAL RANGES OF PHYSICO-CHEMICAL FEATURES OF WATER OF RIVERS GANGA AND YAMUNA AT DIFFERENT STATIONS IN 1988 AT ALLAHABAD

Parameters	Mehdaurighat	Fatehpurghat	Mavaiya	Manaiya	Kakarahaghat	Sujawan
Water Temp (°C)	17.5-31.5	21.0-33.0	19.5-32.0	20.5-33.0	18.0-32.0	19.0-33.0
Transparency (cm)	7.0-60.0	8.0-66.0	5.0-66.0	6.0-72.0	4.0-145.0	5.0-88.0
pH	7.07-7.95	7.16-7.72	7.07-7.76	7.2-8.06	6.40-7.77	7.34-7.76
Free CO_2(mg l^{-1})	Nil - 12.0	Nil - 6.0	Nil - 13.0	Nil - 7.0	Nil - 10.0	Nil - 6.0
Carbonate alkalinity (mg l^{-1})	Nil - 10.0	Nil - 10.0	Nil - 15.0	Nil - 15.0	Nil - 14.0	Nil - 15.0
Bicarbonate alkalinity (mg l^{-1})	78.0-410.0	78.0-208.0	80.0-402.0	92.0-328.0	84.0-360.0	88.0-250.0
Specific conductivity umhos/cm	180.0-691.0	181.0-522.0	190.0-778.0	194.0-610.0	187.0-888.0	187.0-627.0
Total dissolved solids (mg l^{-1})	90.0-346.0	90.0-261.0	96.0-390.0	97.2-305.0	94.0-445.0	93.0-314.0
Nitrate (mg l^{-1})	0.09-1.36	0.09-0.80	0.11-1.22	0.11-0.76	0.11-1.12	0.10-0.68
Phosphate (mg l^{-1})	0.08-1.28	0.09-0.78	0.10-1.18	0.12-0.78	0.12-1.10	0.11-0.70
Gross primary organic carbon producti (mg C $m^{-2}h^{-1}$)	41.6-112.5	62.5-225.0	-	58.3-156.25	31.25-121.4	50.0-133.3
Net organic carbon production mg C $m^{-2}h^{-1}$)	23.0-47.6	32.81-62.5	-	30.0-81.25	18.75-71.40	23.2-87.5
Respiration (mg C $m^{-2}h^{-1}$)	11.25-82.5	15.0-195.0	-	20.0-112.5	12.5-82.8	25.0-80.0

Mavaiya : (industrial effluents). This centre received effluents from ITI, BPCC and other industrial units. The plankton population was of a lower order than that at Mehdaurighat (upstream). It was estimated at 8797, 553 and 822 u l^{-1} at OF, AOF and BOF, respectively.

Benthic organisms were more abundant at BOF (0-2288 u cm^{-2}) than at OF (0-880 u cm^{-2}). However at OF, molluscs dominated (72.00%) over all others. The high plankton production at the outfall may be related to high values of nutrients. Variation in the chemical parameters was not significant at AOF and BOF.

Freshwater zone (upstream)

Fatehpur : The plankton population ranged between 80 u l^{-1} in September and 985 u l^{-1} in February, the average being 363 u l^{-1}

The benthic population was maximum in June being 660 u m^{-2}. The species showed a broad variation in their distribution.

Manaiya(downstream) : The plankton population showed a unimodal distribution. The same trend was witnessed at Fatehpur too. It fluctuated from 50 u l^{-1} in June to 7000 u l^{-1} in February, average being 8794 u l^{-1}.

Benthic population ranged from 176 u cm^{-2} in September to 2288 u m^{-2} in May. The reason for high level of planktonic and benthic population at Manaiya than at Fatehpur may be ascribed to the high status of nutrients in river water at Manaiya due to industrial and sewage pollutants discharged into the rivers Ganga and Yamuna at Allahabad.

River Yamuna, Allahabad

Physico-chemical parameters of the water : The values of various ecological parameters are portrayed in Table 9. Low values in respect of dissolved oxygen and pH were observed at the OF of polluted zones whereas nitrate, phosphate, total alkalinity, specific conductivity and total dissolved soilds were high at this point.

Impact of pollution on biota

Kakrahaghat : Dominance of phytoplankton (91.44%) over zooplankton (8.56%) was observed. Among phytoplankton, abundance of Chlorophyceae and Myxophyceae was recorded at OF zone. This indicated that there was hardly any effect of effluent discharge on the planktonic fauna. Rotifers formed the bulk of zooplankton.

In the freshwater zone (Sujawan), phytoplankton continued to dominate (87.38%) over zooplankton (11.62%).

Benthic population remained at a low ebb. In general, adverse effect of pollution over benthic organisms was not discernible. Discharge of the effluent did not cause sedimentation at the river bed.

Varanasi

Primary production : The primary production at Assighat and Basantaghat above OF and BOF was measured. The gross and net productions fluctuated between 34.01 and 158.3 mg C m^{-2} h^{-1} and 25.00 and 104 mg C m^{-2} h^{-1} respectively. The respiration rate varied from 15.00 to 106.2 mg C m^{-2} h^{-1}. The values were high in freshwater zone than in BOF except in September (Table 7).

Physico-chemical characteristic of the water : Data are presented in Table 7. The impact of sewage discharge through Basanta and Assinallah was quite significant on ecological parameters. The impact was more pronounced in the former. It may be emphasised that the original Assinallah was diverted at Nagwa side where discharge was drained into the river. Due to pollution 600 m downstream of river, water appeared blackish in colour.

Impact of pollution on biota

Assighat : On an average, plankton population was found to be 92 u l^{-1}, 411 u l^{-1} and 413 u l-1 at OF, AOF and BOF respectively. It was even lower than in freshwater zone of Allahabad. The zooplankton percentage was observed lower at OF (19.96) and BOF (22.45) and higher at AOF. Two pulses in plankton production were observed *i.e.* one in summer and another in post-monsoon.Similar trend was witnessed in the production of benthos. Numerical abundance was of high order (5845 u cm^{-2}) at OF followed by BOF (1654 u cm^{-2}), and AOF (85 u cm^{-2}). Odonates appeared in moderate percentage (11.76%) at AOF indicating suitability of the habitat.

The reasons for low zooplankton production at OF may be ascribed to low oxygen (1.22 ppm) high BOD (30-266 ppm) and COD (12-84 ppm) contrary to higher production of zooplankton at AOF and BOF due to lowering of COD and BOD values. This was probably due to dilution accompanied by optimum values of nitrate (0.42-0.68 ppm) and phosphate (0.42-0.62 ppm) in the ecosystsem. The high nutrient load and sandy stratum favoured annelid production.

Basantaghat (Rajghat) : Plankton population was of high order at OF (3072 u/l) followed by BOF (1240 u/l) and AOF (881 u/l). The production of zooplankton was about 4 to 8 times more in current year than in the previous year. The above findings indicated that sewage pollution was considerably reduced.

Benthic fauna closely followed the pattern of plankton, distribution being 115, 150 and 135 u m^{-2} at OF, AOF and BOF respectively. A decrease in annelid population and an increase in molluscan population, besides improvement in the chemical parameters indicated reduction in the magnitude of pollution.

Patna

Physico-chemical studies of water : The effluents of Bata Factory at Digha are characterised by very high values of free CO_2 (23.1 mg l^{-1}), HCO_3 (308.7 mg l^{-1}), specific conductivity (638.5 µmhos) TDS (313 mg l^{-1}) and low values of DO (1.79 mg l^{-1}) and pH (7.2). On many occasions oxygen was nil indicating high BOD. But the quantum of discharge was of a low order and it did not show any impact on the quality of the Ganga where oxygen (av. 7.23 mg l^{-1}) and pH (7.79) were quite high and carbondioxide (1.7 mg l^{-1}), HCO_3 (127.2 mg l^{-1}) specific conductivity (293.2 µmhos) and TDS were low. The sewage effluents at Rajapur were also characterised by high values of CO_2 (24.2 mg l^{-1}), HCO_3 (278.3 mg l^{-1}), specific conductivity (635.3 µmhos), TDS (309 mg l^{-1}) and BOD and low values of DO (2.14 mg l^{-1}) and pH (7.18). But the Ganga at Rajapur showed high values of DO (6.93 mg l^{-1}) and pH (7.75) and low values of CO_2 (2.5 mg l^{-1}), HCO_3 (131.3 mg l^{-1}), specific conductivity (310.5 µmhos) and TDS (153 mg l^{-1}).

The water quality of Punpun and Ganga differ considerably, especially in respect of HCO_3, specific conductivity and DS. The values of these chemical parameters were much higher in Punpun (HCO_3 158.3 mg l^{-1}, specific conductivity, 384.0 µmhos, and TDS 189 mg l^{-1}) than their corresponding values in the Ganga (131.2 mg l^{-1}, 306 µmhos and 150 mg l^{-1} respectively). However, the Gandak showed considerably lower values of the above chemical parameters (105.3 mg^{-1}, 267.3 µmhos and 130 mg l^{-1}) than the Ganga (129.3 mg l^{-1}, 279.9 µmhos and 137 mg l^{-1}). DO and pH were more or less similar in all the places with slight variations.

Study of primary productivity in River Ganga

Studies were made in the Ganga at different places using Radio isotope carbon^{-14} technique. Net primary production rate (mg cm^{-2} day^{-1}) in Ganga ranged from 12.12 to 547.68 (av. 292.46) at Digha; 33.00 to 298.8 (av. 133.0) at Rajapur 9.56 to 536.4 (av. 202.0) at Fatuha and 16.92 to 588.36 (av. 280.11) at Hajipur. Among the two tributaries, Punpun showed much higher production rate (90.72 to 1190.04 mg cm^{-2} day^{-1}; av. 570.74 mg cm^{-2} day^{-1}) than the Gandak (95.4 to 699.36 mg cm^{-2} day^{-1}). Both plankton and benthos populations were higher in the OF region of Rajapur and Digha Bata. The rate of energy fixation by producers was higher at Digha Bata than at Rajapur.

Plankton in River Ganga

The total plankton population at Digha (u l^{-1}) ranged from 62 to 326 (av. 142) 82 to 358 (av. 196) and 98 to 340 (av. 226) at AOF, OF and BOF regions respectively while at Rajapur, the total plankton (u l^{-1}) ranged between 54 and 158 (av. 96), 90-264 (av. 152) and 62-212 (av. 130) at AOF, OF and BOF respectively. Plankton population was comparatively more BOF at Digha Bata and OF at Rajapur showing a positive impact of effluents on total plankton. Phytoplankton (57 to 64%) dominated over zooplankton (36 to 43%) at all places.

The population of plankton in Punpun at Fatuha ranged from 234 to 615 (av. 407) and that of Ganga from 88 to 214 (av. 145).

The plankton concentration at Ganga at Hajipur ranged from 10 to 232 u l^{-1} (av. 110 u l^{-1}) and in the Gandak 16 to 116 u l^{-1} (av. 49 u l^{-1}). Dominance of phytoplankton over zooplankton was observed in both the rivers.

Benthic fauna

The benthos was poor in both the zones at Digha but at Rajapur maximum density was noted in the AOF region. In the Ganga at Fatuha and Hajipur the benthic population was quite rich ranging from 230 to 1087 at Fatuha and 217 to 3478 at Hajipur. Among the two tributaries, the Punpun showed more concentration of benthos (av. 1211 no.m^{-2}) than the Gandak (av. 543 no. m^{-2}).

Bhagalpur

Physico-chemical parameters

In the freshwater zone of River Ganga at Bhagalpur, water temperature and transparency ranged from 21.0 to 31.5°C and 5.0 to 33.0 cm respectively. D.O. ranged from 5.66 to 8.2 mg l^{-1} and free CO_2 from nil to 3.52 ppm. pH was in the range 7.5 to 8.4. Carbonate and bi-carbonate alkalinities ranged from nil to 27.86 ppm and 47.71 to 124.96 ppm respectively. Among dissolved nutrients PO_4, NO_3, SiO_2 Fe(i^c) and Chloride ranged from 0.11 to 0.55 ppm, 0.19 to 0.57 ppm, 3.2 to 6.2 ppm, 0.04 to 0.16 ppm and 26.1 to 52.2 ppm respectively. Specific conductivity ranged from 225.0 to 393.3 micro-mhos per cm at 25°C.

Primary productivity

The primary productivity at OF of sewage at Maniksarkarghat (Bhagalpur) was found to enhance organic carbon production (65.00-605.00 mg C m^{-3} h^{-1}). The community respiration was high (22.50-138.00 mg C m^{-3} h^{-1}).

Energy dynamics of River Ganga

Studies on flow of energy in River Ganga were made at four different places - Kanpur, Allahabad, Varanasi and Patna.

Energy transformation from light to chemical in Ganga

The rate of energy transformation and photosynthetic efficiencies at different places are presented in Table 10.

Kanpur

Studies were made at two different places - Jajmau, where the municipal sewage and tannery wastes are discharged in the Ganga and Bhagwatghat, the discharge point of domestic sewage.

Allahabad

Considerable improvement was noted in the energy transformation by producers in the Ganga at Allahabad, where the studies were made at three different places - Fatehpurghat (freshwater, upstream), Mehdauri (the discharge point of domestic sewage) and Manaiya (downstream). The sewage effluents at Mehdauri appeared to have positive effect on the rate of energy transformation by producers.

Varanasi

In Varanasi, the rate of energy transformation showed further improvement. The average potential at Varanasi (6422 Cal m^{-2} day^{-1}) was higher than that observed at Allahabad.

Patna

Studies were made at four different places, Dighabata, and Rajapur where the effluents are discharged, and Fatuha and Hajipur where the two tributaries Punpun and Gandak meet the Ganga. The average for the whole stretch was 2188 Cal m^{-2} day^{-1} (0.113% of light).

Energy transformation in tributaries of the Ganga

Yamuna

The energy transformation rate was studied in River Yamuna at two different places *viz.* Kakarahaghat and Sujawan. The overall efficiency of energy transformation in the river was 0.08%.

Rivers Punpun and Gandak

Among the two major tributaries which meet the Ganga in Bihar, the rate of energy transformation was higher in the Punpun 891 to 11,690 Cal m^{-2} day^{-1} (av. 4986 Cal m^{-2} day^{-1}) than in the Gandak 937 to 6868 Cal m^{-2} day^{-1} (av. 3989 Cal m^{-2} day^{-1}).

Flow of energy in the biotope

The productive efficiencies and flow of energy in river Ganga from solar radiation to fish from upper stretch (Kanpur) through middle stretch (Allahabad, Varanasi, Patna, upto Bhagalpur) have been shown in Table 11. It is obvious from these observations that productive potential of River Ganga has declined sharply at Kanpur due to deterioration in water quality by the discharge of large amount of pollution in the Ganga around Kanpur. A comparison of productive potential at the above places and the actual energy output as fish clearly indicated that the extent of energy utilisation is only 11.55%, 27.25% and 25.74% of the potential at Allahabad, Bhagalpur and Patna respectively.

Sub-Project (e): **Economics of riverine capture fisheries operations.**

i **Price spread of riverine catch**

ii **Market arrivals of landings and price behaviour.**

The analysis of data collected from two wholesale and one retail fish market showed *C. catla* commanded the highest wholesale price (Rs.21.67/kg). Because of the consumer preference, *L. rohita* fetched the highest retail price (Rs.30.36/kg). Price variation due to size of fish was higher for carps than for catfishes.

The price spread for riverine catch revealed increased shares of retailers and wholesalers in consumer's rupee from 18.18 to 24.91% and 6.51 to 7.91%, respectively. Increased wholesaler's share was due to increase in commission for them, during the year. This, in turn, decreased the fishermen's share in retail price.

The relationship between price and fish landings haas been studied through regression analysis by OLS linear model. It accounted for a very low variation in price.

The sub-project has been extended to Patna and Bhagalpur research stations. A survey of all fish markets at both the places was conducted.

TABLE - 11. ENERGY DYNAMICS OF RIVER GANGA - PRODUCTIVITY EFFICIENCIES AT DIFFERENT STRETCHES

Parameters	Kanpur	Allahabad	Varanasi	Patna	Bhagalpur
1. Light energy on the water surface (K cal ha^{-1} yr^{-1})	67,05,050 X 10^3	68,14,550 X 10^3	68,43,750 X 10^3	68,07,250 X 10^3	6 8,40,100 X10^3
2. Chemical energy fixed by producers (K cal ha^{-1} yr^{-1})	84,05,950	2,61,85,100	2,16,70,050	1,04,82,800	1,50.52,600
3. Potential chemical energy as fish (K cal ha^{-1} yr^{-1})	96,216	2,98,000	2,46,480	1,35,792	1,71,348
4. Actual energy harvest as fish (K cal ha^{-1} yr^{-1})	-	34,428	-	37,003	44,100
5. **Efficiencies**					
i) Light/Chemical	0.124	0.384	0.317	0.154	0.220
ii) Light/Potential	0.00143	0.0044	0.0036	0.0020	0.0025
iii) Light/Actual fish	-	0.0005	-	0.0054	0.00064
iv) Chemical/Fish	-	0.132	-	0.353	0.293
v) Potential/Actual (extent of utilization)	-	11.55	-	27.25	25.74

PROJECT FC/B/9

INVESTIGATIONS ON FACTORS RELATING TO DECLINE IN FISHERY OF THE RIVER BRAHMAPUTRA AND ITS TRIBUTARIES

Personnel : S.P. Singh, S.N. Mehrotra, Y.S. Yadava, M. Choudhury, B.K. Biswas, D.K. Biswas

Duration : 1985-1990

Location : Guwahati

Catch statistics

The estimated fish landings at Uzanbazar, Fancybazar and Jorhat were 36.3 t, 10.1 t and 16.1 t respectively as against 46.1 t, 59.4 t and 179.0 t during the corresponding period of previous year, thereby showing decline in the overall catch at all the centres (Table 1). At Guwahati centre, the major carp landing were dominated by *L rohita*, followed by *C. catla* and, amongst the large catfishes, *W. attu* was dominant followed by *M. seenghala*. At Jorhat centre, landings were dominated by catfishes followed by miscellaneous group (Table 2).

TABLE - 1. MONTHLY FLUCTUATIONS OF FISH CATCH (t) AT DIFFERENT FISH LANDING CENTRES DURING THE YEAR 1988.

FIGURES IN THE PARENTHESES ARE FOR THE CORRESPONDING PERIOD OF THE PREVIOUS YEAR

Months	Uzanbazar	Fancybazar	Jorhat
April	1.67 (7.24)	1.95 (9.08)	2.34 (7.53)
May	2.06 (6.54)	1.14 (7.38)	3.45 (10.99)
June	2.21 (5.89)	1.47 (5.84)	1.95 (10.57)

July	4.34 (9.79)	1.50 (5.45)	1.48 (10.76)
August	3.23 (13.42)	0.43 (6.12)	1.09 (16.33)
September	4.61 (16.52)	1.92 (6.62)	1.32 (20.43)
October	7.79 (21.24)	0.85 (7.12)	2.89 (4.09)
November	3.48 (12.22)	0.34 (9.35)	1.32 (41.11)
December	6.96 (3.21)	0.53 (2.42)	0.50 (57.38)
Total	**36.34** **(96.07)**	**10.12** **(59.37)**	**16.34** **(179.19)**

TABLE - 2. SPECIES-WISE LANDINGS (t) OF SOME COMMERCIALLY IMPORTANT SPECIES AT DIFFERENT CENTRES

Species	Uzanbazar	Fancybazar	Jorhat
L. rohita	1.59	0.97	1.28
C. catla	0.76	0.29	1.08
C. mrigala	0.53	0.09	0.13
L. calbasu	0.76	0.09	-
Total Major carps	3.64	1.44	2.49
L. qonius	1.30	0.10	0.79
C. reba	1.15	-	0.04
L. bata	1.14	0.12	0.32
Total Minor carps	3.89	0.22	1.15
W. attu	7.23	1.48	0.90
M. seenghala	0.61	0.20	0.35
M. aor	0.54	0.03	0.34
Total Large catfish	8.38	1.71	1.59
Other catfishes	1.80	0.36	4.09
N. chitala	0.39	0.14	1.04

N. notopterus	0.64	-	-
Total Featherback	1.03	0.14	1.04
H. ilisha	4.94	3.33	0.16
Others	12.66	2.92	5.82
Total	**36.34**	**10.12**	**16.34**

The decline in fish landings at all the centres may be ascribed to the unprecedented and prolonged high floods in the river followed by the outbreak of fish disease (Epizootic Ulcerative Syndrome) in the region.

Environment Impact Assessment

Abiotic features : The paper mill effluents from Hindustan Paper Corporation, Jagi Road, which are discharged into Elanga Group of beels are characterised by high alkaline values (250-630 mg l^{-1}) with pH ranging between 6.5 and 8.5. High conductivity (956-1353 μ mhos cm^{-1}) and total dissolved soilds (480-695 mg l^{-1}) indicated, intense ionisation of the effluents. The highly unsaturated effluent consumes almost the entire D.O. of the beel water resulting in destruction of the autotrophic elements. Low values of D.O. (0.64-1.28 mg l^{-1}) were registered in and around the outfall points (sector 1), accompanied with high concentrations of free CO_2 (36-80.6 mg l^{-1}). Carbon fixation in the beel was of a very low order (GPP, 24.4-33.3 mg C m^{-3} hr^{-1}; NPP, 11.0-33.3 mg C m^{-3} hr^{-1}; RESP., 0-13.3 mg C m^{-3} hr^{-1}).

The water quality of the beel at its confluence site with River Kollong (sector III) showed stabilization due to oxidation and dilution of the effluents. The water quality parameters at this site ranged as below :

pH	7.4-7.6
Free CO_2	26.0-40.0 mg l^{-1}
D.O.	2.88-5.4 mg l^{-1}
Alkalinity	160-190 mg l^{-1}
Conductivity	764-870 u mhos cm^{-1}
Total dissolved solids	36-430 mg l^{-1}
GPP	83.34 mg C m^{-3} hr^{-1}
NPP	33.3 mg C m^{-3} hr^{-1}
Respiration	60.0 mg m^{-3} hr^{-1}

Water quality of River Brahmaputra was assessed at Noonmati (upstream of Guwahati city) and Saraighat (downstream of Guwahati city) (Table 3). Besides the

Noormati oil refinery discharge at Saraighat, the river also receives domestic sewage at several points within this stretch.

TABLE -3 . PHYSICO-CHEMICAL FEATURES (RANGE) OF RIVER BRAHMAPUTRA AT NOONMATI AND SARAIGHAT SITES

Sl.No.	Parameters	Noonmati	Saraighat
1	Water temperature (°C)	16.5-28.2	16.5-26.0
2	Transparency (Cm)	10.0-50.0	10.0-49.0
3	pH	7.4-8.6	7.6-7.8
4	Free CO_2 ($mg\ l^{-1}$)	0.0-10.0	0.0-16.0
5	Dissolved oxygen ($mg\ l^{-1}$)	5.12-9.6	5.0-8.96
6	Total alkalinity ($mg\ l^{-1}$)	40.0-96.0	50.0-84.0
7	Conductivity (μ mhos cm^{-1})	97.5-166.0	102.0-174.0
8	Total dissolved solids ($mg\ l^{-1}$)	49.1-82.0	51.0-81.0
9	GPP ($mg\ C\ m^{-3}\ hr^{-1}$)	0.0-225.0	25.0-70.3
10	NPP ($mg\ C\ m^{-3}\ hr^{-1}$)	22.0-75.0	0.0-100.0
11	Respiration ($mg\ C\ m^{-3}\ hr^{-1}$)	(-) 75.0-200.0	(-) 75.0-25.0

It is apparent from the data presented in Table 3 that the effects of effluent discharge appear to be insignificant due to the enormous water discharge in River Brahmaputra resulting in dilution of the effluents.

Biotic features : Plankton, macrobenthos, macrovegetation and detritus load were studied qualitatively and quantitatively to assess the effluent impact on the biotic assemblage.

Elanga beel : The plankton population in the beel ranged from nil to 3233 u l^{-1} with an average of 579 u l^{-1}. Zooplankton (72.71%) dominated over phytoplankton (27.29%). Plankton density was the highest (1250 u l^{-1}) during monsoon period, presumably due to the dilution of effluents. Summer (325 u l^{-1}) and winter (300 u l^{-1}) recorded almost identical densities.

The phytoplankton structure in the beel was in the order, Bacillariophyceae (63.29%) > Conjugatophyceae (18.35%) > Myxophyceae (10.76%) > Euglenaceae (4.43%) and > Chlorophyceae (3.16%). The zooplankton was composed of Cladocera (74.58%) > Rotifera (14.73% > Copepoda (5.70%) and > Rhizopoda (4.99%). Of the 16 taxa enumerated in phytoplankton, 9 constituted *c.* 90% of the population. In zooplankton 13 taxa were recorded of which 5 constituted *c.* 90% of the population.

Macrobenthos density in Elanga beel ranged from 10 to 8008 Nos. m^{-2} with an average of 5999 Nos. m^{-2}. Pelecypoda (72.99%) dominated the benthic population followed by Gastropoda (15.24%), Diptera (7.53%), Oligochaeta (3.87%), Odonata (0.29%) and Coleoptera (0.07%).

Mainly, the outfall zone (sector I) was infested with aquatic vegetation. *Eichhornia crassipes* was the dominant macrophyte followed by *Pistia* sp. and marginal grasses. Infestation (dry wt.) ranged from 24.0 g m^{-2} to 90.0 g m^{-2}.

Detrital load (dry wt.) in Elanga beel varied from 76.3 g m^{-2} to 2077.6 g m^{-2} during the period April 1988 to January 1989. The outfall zone (sector I) registered the maximum values (660.1 ± 629.01 g m^{-2}) followed by sector III (427.4 ± 270.50 g m^{-2}) and sector II (328.2 ± 28.32 g m^{-2}).

Noonmati and Saraighat : Plankton in River Brahmaputra ranged from 33 to 367 u l^{-1} (av. 134 u l^{-1}) at Noonmati and 33 to 237 u l^{-1} (av. 95 u l^{-1}) at Saraighat sites. The slight deterioration in water quality was evident from the relatively low population of the plankters at Saraighat site. The phytoplankton dominated over zooplankton at both the sites.

Bacillariophyceae and Chlorophyceae constituted the phytoplankton of which the former contributed 88.98% (Noonmati) and 63.74% (Saraighat) to the plankton density. Zooplankton comprised one group each at Noonmati (Rotifera) and Saraighat (Copepoda) during the study period. The phytoplankton comprised 7 taxa while zooplankton was represented by a single taxon at both the sites.

Dipteran larvae (*Chironomus* and *Culicoides*) and Oligochaeta (*Tubifex* sp) constituted the macrobenthic population of the River Brahmaputra at Noonmati and Saraighat sites. The benthic density was poor with an average of 27 Nos. m^{-2} at Noonmati and 65 Nos. m^{-2} at Saraighat. The increased benthic density with a dominating population of *Chironomus* larvae lends support to the existence of slightly deteriorated condition of Brahmaputra waters at Saraighat site. The values of organic detritus (dry weight) further corroborates the observations. Detritus ranged from 15.3 to 85.8 g m^{-2} (av. 62.3 g m^{-2}) at Noonmati and 21.6 to 173.1 g m^{-2} (av. 66.1 g m^{-2}) at Saraighat site.

PROJECT FC/B/10

EVALUATION OF FISH COMMUNITY STRUCTURE IN THE CONTEXT OF ENVIRONMENTAL MODIFICATIONS IN RIVER YAMUNA

Personnel : S.K. Wishard (upto 7.1.1989), D.N. Mishra (Upto 19.4.1988), (Smt.) Usha Moza (from 3.8.1988), K. Chandra (from 25.5.1988), V. Kolekar (from 31.12.1988), Ramji Tiwari (26.7.1988), Sudarsan Bandopadhyay (from 14.12.1988).

Duration : 1988

Location : Agra

Sub-Project A. **Estimation of biological and population parameters of commercially important fish species.**

Agra centre was established in March 1988 and the work was initiated in June 1988. The area was surveyed and sampling centres were identified at Agra, Mathura and Etawah for the collection of catch statistics as well as hydrobiological data.

Estimated monthly landings at Agra have been shown in Table 1. Maximum landings of major carps (44.75%) and minimum of catfish (5.63%) were observed in the month of July.

In the dry season (June and part of July) drag nets were operated in deeper parts of the river, harbouring major carps. Later in monsoon and post-monsoon months, more and more hook and lines were operated especially to catch catfish, murrels and *Notopterus spp.* Small drag nets were operated during post-monsoon months in leftover pools to strain out all available fish.

Table 2 shows the species composition and monthly landings from Mathura landing centre where catfishes dominated in most of the months.

At Etawah also, large catfish dominated in the total catch (49.55%) followed by miscellaneous group and major carps, contributing 25.25% and25.19% respectively (Table 3).

Among the three centres, Agra offered the bulk of catch followed by Etawah and Mathura.

TABLE - 1. ESTIMATED FISH LANDINGS AT AGRA DURING JUNE - DECEMBER 1988

Species	Months								
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Percentage
C. mrigala	506.25	2021.34	461.47	530.81	214.82	227.69	103.07	4065.45	
C. catla	135.00	1844.70	1691.96	226.12	96.14	26.10	178.44	4198.46	
L. rohita	692.44	2862.60	770.22	210.94	153.59	358.66	190.84	5239.29	
L. calbasu	562.50	1260.93	1169.15	546.94	388.03	227.69	195.69	4350.93	
Total :	**1896.19**	**7989.57**	**4092.80**	**1514.81**	**852.58**	**840.14**	**668.04**	**17854.13**	23.98
%	**10.62**	**44.75**	**22.92**	**8.45**	**4.77**	**4.70**	**3.74**		
M. aor	10.50	-	-	61.87	1.37	105.50	199.17	378.41	
M. seenghala	281.81	484.18	1396.64	127.31	1330.42	1983.13	1618.97	9751.46	
W. attu	848.81	1530.11	1142.77	5561.62	5679.78	6091.72	3579.80	24433.99	
Total :	**3670.12**	**2014.29**	**2539.41**	**5750.80**	**7011.57**	**8180.35**	**5397.32**	**34563.86**	56.29
% :	**10.61**	**5.83**	**7.35**	**16.64**	**20.28**	**23.67**	**15.61**		
R. rita	532.50	562.44	827.32	1762.50	435.16	258.54	114.31	4493.17	
S. silondia	137.90	-	54.52	-	6.88	66.34	15.50	281.14	
L. bata	403.12	101.48	215.00	318.75	142.75	66.34	57.16	1304.60	
B. bagarius	86.25	-	25.80	153.75	25.80	271.78	172.44	735.82	
Murrels	75.00	147.92	146.20	273.75	283.80	663.40	1011.37	2591.44	
E. vacha	174.37	51.60	15.48	6.00	89.09	603.48	-	940.82	
C. garua	-	-	-	9.37	-	-	77.50	86.87	
Shrimps	13.12	185.76	144.48	-	-	-	-	346.36	
N. chitala	25.50	-	17.20	129.37	36.12	77.04	66.84	352.07	
Misc.	122.44	233.92	463.37	763.12	753.36	1866.08	968.74	5371.03	
Total :	**1570.20**	**1283.12**	**1909.37**	**3416.61**	**1772.96**	**3873.40**	**2483.86**	**14809.52**	23.73
	% :	**9.63**	**7.87**	**11.71**	**20.95**	**10.81**	**23.75**	**15.23**	

TABLE - 2. ESTIMATED FISH LANDINGS AT MATHURA DURING AUGUST-DECEMBER 1 988

Species	Months						
	August	September	October	November	December	Total	%
C. mrigala	142.50	130.50	50.37	------	20.15	343.52	
C. catla	-	47.25	81.37	------	35.65	164.27	
L. rohita	99.20	84.00	37.20	48.00	----	268.40	
L. calbasu	124.77	635.25	159.65	394.50	416.17	1730.34	
Total :	**366.47**	**897.00**	**328.59**	**442.50**	**471.97**	**2506.53**	
% :	**14.62**	**35.79**	**13.11**	**17.65**	**18.83**	**99.99**	
M. aor	----	----	----	----	----	----	
M. seenghala	146.47	469.50	442.52	786.00	1280.30	3106.79	
W. attu	151.90	252.75	1205.12	516.00	1392.67	3518.44	
Total :	**298.37**	**722.25**	**1647.64**	**1284.00**	**2672.97**	**6625.23**	
% :	**4.50**	**10.90**	**24.87**	**19.38**	**40.34**	**99.99**	

contd..

Table 2 continued

Species	Months					
	August	September	October	November	December	Total %
R. rita	155.00	397.50	193.75	----	317.75	1064.00
S. silondia	----	----	----	----	----	----
L. bata	54.25	82.50	----	----	155.00	291.75
B. bagarius	----	----	----	----	263.59	263.50
Murrels	----	202.50	643.25	165.00	162.75	1173.50
E. vacha	3.87	22.50	----	----	62.00	88.37
C. garua	----	----	----	----	----	----
Shrimps	----	----	----	----	----	----
N. notopterus	----	----	209.25	----	77.50	286.75
N. chitala	----	----	----	----	----	----
Misc.	651.00	187.50	627.75	315.00	395.25	2176.50
Total :	**864.12**	**892.50**	**1674.00**	**480.00**	**1433.75**	**5344.37**
% :	**16.17**	**16.70**	**31.25**	**8.98**	**26.82**	

TABLE - 3 . ESTIMATED FISH LANDINGS AT ETAWAH DURING AUGUST-DECEMBER 1988

Species	Months August	September	October	November	December	Total	%
C. mrigala	1172.57	345.00	437.10	137.25	112.37	2204.29	
C. catla	1410.50	37.50	186.00	132.00	106.95	1872.95	
L. rohita	930.00	72.00	12.40	69.75	210.80	1294.95	
L. calbasu	504.52	179.25	368.12	335.25	386.72	1773.86	
Total :	**4017.59**	**633.75**	**1003.62**	**674.25**	**816.84**	**7146.05**	
% :	**56.22**	**8.86**	**14.04**	**9.43**	**11.43**		
M. aor	----	----	571.17	----	----	571.17	
M. seenghala	1.55	2155.55	2223.47	576.75	1568.60	6525.92	
W. attu	416.17	1641.75	1542.25	969.00	2388.55	6957.72	
Total :	**417.72**	**3797.30**	**4336.89**	**1545.75**	**3957.15**	**14054.81**	
% :	**2.97**	**27.02**	**30.85**	**11.00**	**28.15**		
R. rita	317.75	232.50	162.75	37.50	325.50	1076.00	
S. silondia	----	----	77.50	----	----	77.50	
L. bata	155.00	37.50	38.75	112.50	85.25	429.00	
B. bagarius	----	300.00	364.25	255.00	162.75	1082.00	
Murrels	122.45	300.00	1201.25	157.50	356.50	2137.70	
E. vacha	----	22.50	----	----	----	22.50	
C. garua	----	----	----	----	----	----	
Shrimps	----	----	----	----	----	----	
N. notopterus	----	112.50	----	37.50	----	150.00	
N. chitala	----	----	----	----	----	----	
Misc.	387.50	225.00	604.50	420.00	550.25	2187.25	
Total :	**982.70**	**1230.00**	**2449.00**	**1020.00**	**1480.25**	**7161.95**	
% :	**13.72**	**17.70**	**34.19**	**14.24**	**20.67**		

The gut contents of 30 specimens of *W. attu* (size 315-647 mm) were examined during this period from river Yamuna. The gut contents comprised semidigested fish matter (55.77%), fishes (31.92%), insect (8.57%), sand and mud (2.78%) and plant matter (0.96%).

Sub-Project B : **Abundance pattern of various biotic communities in relation to environmental changes.**

About 1.5 lakh spawn were collected at a survey conducted by the State Fisheries Department at Balkeshwar temple site on 28th & 29th July 1988 which included carp spawn also.

Sub-Project C : **Abiotic determination of production functions in the ecosystem.**

With a view to studying the factors responsible for the decline of fisheries in selected stretches of river Yamuna, a preliminary survey was conducted in July 1988 for selection of sampling centres at Agra, Mathura and Etawah. Three centres were selected upstream, midstream (Water Works) and downstream (Power House Nallah downstream of Taj) in Agra. At Mathura, one centre, Swami Ghat, was selected for the study. At Etawah, two centres *viz.*, Dhobighat and Taxistand nallah were selected for the study.

Characterization of sewage water at Agra, Mathura and Etawah is portrayed in Table 4.

Plankton studies indicated that phytoplankton formed the bulk of planktonic fauna. Diatoms and Myxophyceae virtually determined the phytoplanktonic abundance. The data have been pooled and presented sector-wise in Figure 1, to study the sectoral variations.

The outfall and below outfall area of all the three centres both Myxophyceae and diatoms were present. At Agra and Mathura, Myxophyceae formed 33 to 66% of total population while diatoms formed 30 to 45%. But at Etawah, from October onwards, diatoms recorded an average population of 22%, Myxophyceae 14% and Desmids 8% of total population. The dominant forms of various groups were *Cyclotella, Microcystis, Staurastrum* and *Peridinium.* Zooplankton at Agra and Mathura represented 17 to 19% and 16 to 33% of total population respectively. At Agra, zooplankton were represented by both Protozoa and Copepoda, dominant forms being *Difflugia* and nauplius. But at Mathura, only protozoans were present. At Etawah, zooplankton were encountered regularly, their average numerical abundance being 33 to 56% of total population. Copepods were the dominant group in summer, but protozoa and rotifers were present during successive months. *Difflugia* was the prominent protozoan and *Brachionus sp.* and *Keratella sp.* were the dominant rotifers.

The steep increase in plankton population during November at Etawah may be due to the total isolation of this zone from main stream from October onwards, due to decrease in water level. But from December onwards, due to more inflow of water from near by dam, it again becomes a running water system wherein plankton population gets diluted.

TABLE - 4. SHOWING CHARACTERIZATION OF SEWAGE WASTES AT AGRA, MATHURA AND ETAWAH * 1988-89

Parameters/Station	Agra				Mathura			
	Sewage waste	AOF	OF	BOF	Sewage waste	AOF	OF	BOF
Temperature (°C)	15.0-30.5	50.0-30.5	50.0-30.5	15.0-30.5	15.5-30.0	15.5-31.0	15.5-30.5	15.0-30.5
pH	7.0-8.20	7.2-8.10	7.2-8.0	7.15-8.20	7.2-8.85	7.0-8.10	7.0-7.79	7.0-9.2
Alkalinity (mg l^{-1})	560-750	124-310	310-418	270-642	340-570	130-200	210-480	218-496
D.O. (mg l^{-1})	0.5-3.5	6.8-8.4	5.0-6.8	4.8-6.8	3.6-6.8	6.4-8.6	5.6-9.2	5.2-8.84
Sp. conductivity (micro mhos cm^{-1})	453-1410	265-356	315-918	310-1052	718-1368	156-220	510-861	521-954
Transparency (cm)	0.5-11.5	10-32.5	11.5-11.0	45-13.5	0.5-18.5	10.5-32.5	10.5-32.5	10.5-18.5
Hardness (mg l^{-1})	68-82	68-78	62-68	66-78	62-78	60-68	68-78	68-78
TDS (mg l^{-1})	227-708	133-179	158-459	156-527	359-605	78-110	255-432	261-474
Free CO_2 (mg l^{-1})	3.5-28.5	1.2-4.8	14.5-23.5	8.5-18.0	1.5-1.8	1.5-9.5	11.0-18.5	11.0-18.0
Free NH_3 (mg l^{-1})	0.5-21.5	-	0.8-17.5	1.8-16.5	1.5-5.5	-	0.5-10.5	1.5-6.4
Chloride (mg l^{-1})	1.0-18.5	1.8-4.5	11.0-17.0	10.5-13.5	9.5-16.5	1.5-3.8	8.5-13.5	8.0-16.5
Silicate (mg l^{-1})	8.5-18.5	8.0-11.5	9.5-16.5	8.0-17.5	1.8-8.5	8.0-10.0	8.5-14.5	8.5-13.0
BOD 5 days at 20°C	54-264	6.8-14.8	48-196	51-184	8.0-16.0 44-78	7.0-9.8	18-59.5	31-68
Gross Carbon mg C m^{-3} hr^{-1}	72.98-416.66	25.94-72.42	61.51-219.54	-	68.58-216.5	31.52-61.56	-	-
Net Carbon mg C m^{-3} hr^{-1}	28.24-86.54	10.43-30.83	19.59-67.05	-	31.52-91.56	11.56-29.09	-	-

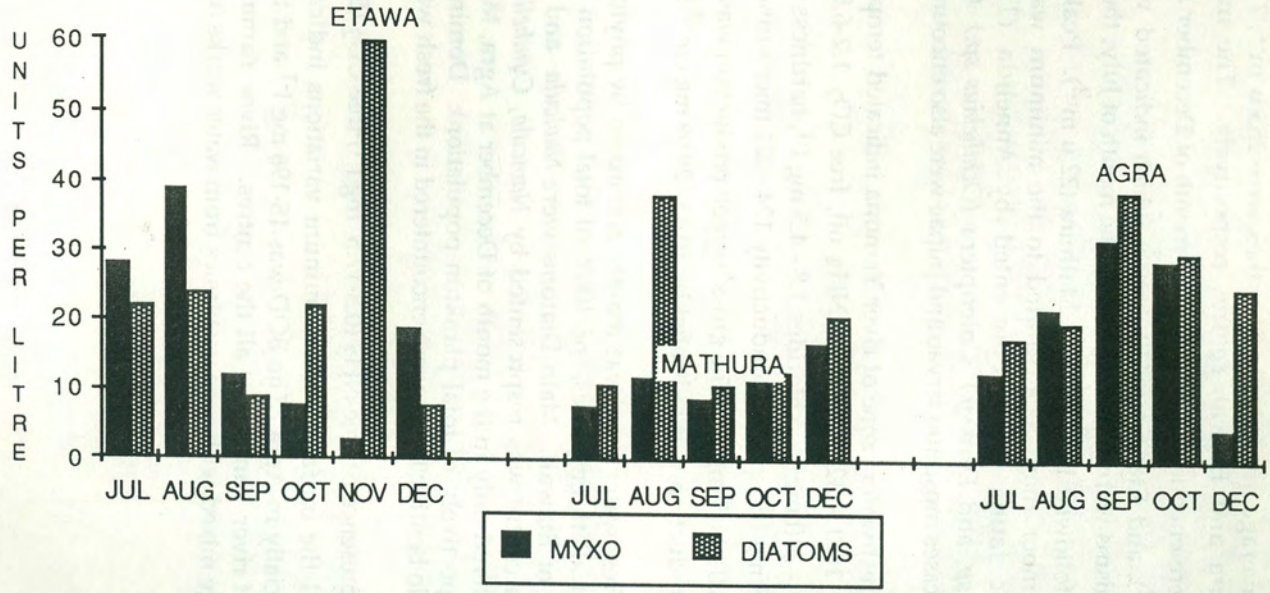
Contd. ...

Table 4 continued

Parameters/Station	Etawah *			
	Sewage waste	AOF	OF	BOF
Temperature (°C)	15.0-30.5	15.0-30.5	15.0-30.5	15.0-30.5
pH	7.0-8.4	7.10-8.40	7.0-7.6	7.0-7.82
Alkalinity (mg l^{-1})	410-680	132-210	218-362	221-492
DO (mg l^{-1})	3.6-5.2	7.2-8.4	6.4-7.6	5.2-6.8
Sp. Conductivity (micro mhos cm^{-1})	516-1054	142-194	362-610	340-410
Transparency (cm)	2.5-10.4	13.5-31.5	13.5-26.5	13.0-28.0
Hardness (mg l^{-1})	60-68	60-68	62-76	62-78
TDS (mg l^{-1})	259-529	71-97	182-306	170-205
Free CO_2 (mg l^{-1})	2.5-18.5	1.5-5.2	5.5-6.8	4.8-8.5
Free NH_3 (mg l^{-1})	2.5-13.6	-	1.5-11.8	0.5-3.5
Chloride (mg l^{-1})	8.5-18.5	1.9-4.8	6.8-14.5	7.5-15.5
Silicate (mg l^{-1})	2.5-15.5	8.0-10.5	10.5-14.5	11.0-14.0
	8.0-17.5			0.8-15.8
BOD 5 days at 20°C	59-172	7.2-11.5	32-58.5	58-118
Gross Carbon mg C m^{-3} hr^{-1}	64.5-318.51	43.59-81.58	-	-
Net Carbon mg C m^{-3} hr^{-1}	61.57-77.51	11.59-29.09	-	-

AOF = Above outfall, BOF = Below outfall, OF = Outfall

FIG I MONTHLY VARIATIONS OF PHYTOPLANKTON IN THREE SECTORS OF THE RIVER YAMUNA



The average annual macrobenthos were 255 u m^{-2}, 2144 u m^{-2} and 1050 u m^{-2} at Agra, Mathura and Etawah centres respectively. The maximum number of benthic organisms were encountered during the month of December at Agra (1461 u m^{-2}, Mathura (12774 u m^{-2}), and Etawah (6170 u m^{-2}) which indicated winter peak while minimum benthic organisms were recorded during the month of July, the organisms were minimum at Etawah (nil) followed by Agra and Mathura (22 u m^{-2}). Peak period of benthic organisms during December may be attributed to the minimum water level of the river. The macrobenthic fauna were represented by Annelida *(Tubifex sp)*, Diptera larvae *(Chironomus sp.* and *Dixa sp.)* Coleoptera *(Ochthebius sp.)* Gastropoda *(Campeloma sp.)* and in some cases mosquito larvae and pupae were also encountered in sewage polluted zone.

The freshwater zone of river Yamuna indicated temperature 15-31°C, pH 7.15-8.20, transparency 10.0 - 32.5 cm, free NH_3 nil, free CO_2 1.2-6.8 mg l^{-1}, DO 7.3 - 8.4 mg l^{-1}, alkalinity 124 - 310 mg l^{-1}, chlorides 1.8 - 4.5 mg l^{-1}, hardness 68- 78 mg l^{-1}, BOD - 5 days at 20°C 6.8 - 14.8 mg l^{-1}, specific conductivity 124 - 321 micro-mhos per cm, TDS 62 - 161 mg l^{-1}, and silicate 8.0 - 11.5 mg l^{-1}. The gross oxygen production was 25.94 - 81.58 mg cm^{-2} hr^{-1} and net oxygen production was indicated by 10.43 - 29.09 mg cm^{-3} hr^{-1} respectively.

The freshwater zone was mainly dominated by phytoplankton, with diatoms being maximum at all three places, 66-100% of total population at Agra, 33-100% of Mathura and 50-100% of Etawah. Main Diatoms were *Navicula* and *synedra* at Agra and Etawah. The Mathura centre was respresented by *Navicula, Cymbella* and *Eunotia*. Zooplankton were encountered only in the month of December at Agra, Mathura and Etawah (42%, 33% and 50% respectively of total plankton population). Dominant forms were *Difflugia* and *Arcella* sp. No benthic fauna were encountered in the fresh water zone of river Yamuna.

The presence of free NH_3 (0.8-17.5 mg l^{-1})·free CO_2 (5.5-23.5 mg l^{-1}) and DO (5.0-9.6 mg l^{-1}) at all the outfalls with minumum variations indicated eutrophication in winter months especially in Agra. The BOD was 18-196 mg l^{-1} and the same was 6.8-14.8 mg l^{-1} in freshwater of river Yamuna at all the centres. River Yamuna at Agra is mostly polluted due to sewage mixed with tannery wastes from water works (upstream) to Taj (downstream).

PROJECT FC/A/4

ECOLOGY AND FISHERY MANAGEMENT OF BEELS IN WEST BENGAL

Personnel : Arun G. Jhingran,K.K. Vass (From August 1988), V.V. Sugunan, G.K. Vinci, G.N. Chattopadhyay (Upto January 1989), M.J. Bhagat, (Mrs.) K. Mitra, N.N. Mazumder

Duration : 1980-1990

Location : Barrackpore

The work was taken up in two beels, both closed and open types, namely the Garapota and Mogra, located in the districts of 24-Parganas.

Physico-chemical limnology

The surface water temperature of both beels ranged between 21-34°C with minimum in winter months and maximum recorded in June. No well-defined thermal stratification at the pelagic site was noted but in Garapota beel a thermal amplitude of 4°C was noted in February. But this kind of stratification breaks during night. The light transparency revealed Mogra beel to be more clear than Garapota. Less transparency in Garapota is ascribed to high plankton populations. The extinction coefficient in Garapota beel ranged from 0.65-1.45 while it ranged from 0.34-1.5 in Mogra beel.

The physico-chemical features of surface water at Garapota and Mogra beels are given in Table 1. Heavy infestation of submerged weeds and photosynthetic activity in Mogra beel resulted in high alkaline condition (7.3-9.7).

TABLE - 1. PHYSICO-CHEMICAL FEATURES OF SURFACE WATER OF GARAPOTA AND MOGRA BEELS (VALUES IN YEARLY RANGES)

Parameter	Garapota	Mogra
Dissolved oxygen (ppm)	5.6-12.2	8.4-22.1
pH (Unit)	8.0-8.7	7.3-9.7
Total alkalinity (ppm)	150-282	88-128
Nitrate - NO_3 (ppm)	0.224-1.008	0.224-1.568

Mogra beel, being infested with aquatic macrophytes, exhibited higher values of soil organic carbon (1.4% average) while it was only 1% in Garapota beel. Similarly, available nitrogen on an average was 34 mg/100 g soil in Mogra beel and 29.4 mg/100 g soil in Garapota beel.

Biological Limnology

Submerged, free-floating, rooted and emergent aquatic macrophytes were encountered in both the beels. In Mogra beel, the dominant species were *Ceratophyllum* (34%), *Najas* (23%), *Hydrilla & Vallisnaria* (18%). In Garapota beel, dominant species were *Hydrilla* (39%), *Ludwgia* (18.7%), *Vallisnaria* (17%) and *Eichhornia* (14%).

The dry weight biomass of macrophytes in Mogra beel ranged between 472-530 g m^{-2} with a peak in July. In Garapota beel, macrophytic biomass ranged between 192-382 g m^{-2}.

The free living macroorganisms and those associated with the macrophytes in two beels were represented by gastropods, arthropods, annelids and nematodes. The average species diversity of these organisms showed no marked difference in two beels (H = 1.01772 bits/u and H = 1.03585 bits/u in Mogra and Garapota beels, respectively). Among different groups, gastropoda were dominant with an average 54.6% in Mogra beel and 85% in Garapota beel. Similarly, the species diversity index with regard to various insect groups was H = 3.2048 in case of Mogra and H = 2.2878 in case of Garapota beel.

Macrobenthic fauna recorded in Mogra beel comprised mainly molluscs, arthoropods and annelids in order of abundance, contributing 35-85.4%, 10-55% and nil-2.74%, respectively. Among molluscs, *Gubla* sp was the most dominant form recorded. Similarly in Garapota beel, macrobenthos was constituted by molluscs (78-82%), arthropods (2.8-11.6%) and annelids (nil-2.5%). There was a definite morphometric variation in population density of benthos in the two beels. Molluscan population was more towards the weed-infested areas.

The Garapota beel was very rich in plankton population with density ranging from 2500-14500 unit l^{-1}. Main forms recorded were *Chlamydomonas, Actinastrum, Gonium, Pediastrum, Ceratium* and *Fragillaria*. During spring season, the beel revealed a bloom of *Ceratium*. In Mogra beel, the plankton density was comparatively low and the species encountered were similar to that of Garapota with Chlorophyceae and Cyanophyceae as the dominant groups.

General Fisheries

i) Fishery of both the beels was constituted by Indian major carps and miscellaneous groups represented mainly by *Gudusia* sp. Major carps formed the bulk of the catch. The food studies revealed that detritus (45.5%) was encountered in *Cirrhinus mrigala* and *Catla catla* (20-12%). Phytoplankton was recorded in *Labeo rohita* (26-40%) and in

Cyprinus carpio (26%). Zooplankton, mainly crustaceans and rotifers, were recorded in *Catla catla* (42-48%). A small percentage of food was composed of semidecayed organic matter.

ii) Both the beels were exploited by the recognised fishermen co-operative societies. The total number of fishing days in a year vary from 290-310. Closed season for fishing also was observed. About 315 fishermen were engaged in Garapota beel and 387 in the Mogra beel. The gear mainly used were cast net, gill net, scoop net, hook and line and traps. "Katal" fishing was also practised and substantial amount of fish was caught by this method. The total carp landings in Garapota beel were estimated at 37,281.50 kg for the year recording a maximum of 12,610.60 kg in November. The Mogra beel recorded a catch of 26,755.75 kg with maximum catch of 5,330.60 kg in October.

Fishery Management Strategy

In both the beels, stock manipulation as a tool of management, was employed, to increase the fish productivity. In Garapota beel, stocking of *Catla catla, Labeo rohita, C.irrhinus mrigala, Cyprinus carpio* and *Ctenopharyngodon idella* was done in the ratio of 60 : 10 :10 :13 : 7, respectively. About 4,276 kg of fish biomass @ 35 Kg/ha was stocked in the beel. Due to higher plankton population stocking rate of *Catla* was kept at the maximum. The details are given in Table 2. The fish yield from the beel ranged between 107-12,610 kg per month which is estimated at an average catch range of 5.6-434 kg/day. By this planned stocking with different species mix of major carps the fish yield has enhanced to 320 kg/ha in the beel.

In Mogra beel, stocking of *C. catla, L. rohita, C. mrigala, C. Carpio,* and *C. idella* was done in the ratio of 26 : 25 : 29 : 3 : 18, respectively. About 5,490 kg of fish biomass @ 91.5 kg/ha was stocked in the beel. Due to higher detritus load, *C. mrigala* was stocked at higher density. The average fish catch in the beel ranged from 1.03 to 187.50 kg/day. By planned stocking an estimated production of 446 kg/ha was achieved.

Energy Transfer

i) Carbon assimilation :

(a) In Garapota beel, phytoplankton carbon fixation showed a significant horizontal and vertical variation. This was directly correlated with the distribution of plankton density. Month to month carbon fixation ranged from a minimum of 510 mg C m^2 d^{-1} in September to 1660 mg C m^2 d^{-1} in April (Table 3). On the other hand in Mogra beel (Table 4) a minimum carbon fixation of 350 mg C m^2 d^{-1} was estimated in December and a maximum of 1420 mg C m^2 d^{-1} in May. On yearly basis, about 4.9 tonnes of carbon was fixed per hectare in Garapota beel while it was estimated at 3.3 tonnes/ha in Mogra beel. In case of macrophytes, the carbon fixation in both the beels ranged between 3.26-18.69 g C m^2 d^{-1}.

TABLE - 2 . FISH STOCKING OF GARAPOTA AND MOGRA BEELS DURING THE YEAR

Species	GARAPOTA				MOGRA			
	No. ha^{-1}	Total wt. (kg)	Average (g)	%	No. ha^{-1}	Total wt. (kg)	Average (g)	%
Catla catla	214	21.4	100	60	2077	18.5	9	26
L. rohita	34	3.44	101	10	2836	14.0	5	25
C. mrigala	34	3.44	101	10	2336	14.0	6	29
C. carpio	46	4.60	100	13	223	33.5	150	3
C. idella	27	2.80	103	7	1413	11.0	8	17
Total :	**355**	**35.7**	**101 (Mean)**		**8885**	**91**	**7 (m) & 150**	(Mean)

Table - 3. PHOTOSYNTHETIC ENERGY FIXATION AND ENERGY CONVERSION IN GARAPOTA BEEL - 1988-89

1.	Location of Beel		=	24°N
2.	(a)	Total average radiant energy received (Cal m^{-2} y^{-1} X 10^8)	=	17
	(b)	Average visible radiation Cal m^2 y^{-1} X 10^8	=	12/6
3.	Phytoplankton photosynthetic production			
	i)	g C m^2 y^{-1}	=	492.7
	ii)	Cal m^2 y^{-1} X 10^5	=	47.3
4.	Macrophytic biomass production			
	i)	g C m^2y^{-1}	=	1192.8
	ii)	Cal m^2 y^{-1} X 10^5	=	114.6
5.	Photosynthetic efficiency (%)			
	i)	Phytoplankton	=	0.375
	ii)	Macrophytes	=	0.91
6.	Fish Production			
	i)	kg ha^{-1} y^{-1}	=	318
	ii)	g m^2 y^{-1}	=	31.8
	iii)	Cal m^2 y^{-1}	=	38160
7.	Conversion efficiency (%)			
	i)	Total primary production to fish	=	0.235
	ii)	Light energy to fish	=	0.003

TABLE - 4. PHOTOSYNTHETIC ENERGY FIXATION AND ENERGY CONVERSION IN MOGRA BEEL - 1988-89

1.	Location of Beel	=	24°N
2.	a) Total Average radiant energy received $Cal\ m^2\ y^{-1} \times 10^8$	=	17
	b) Average visible radiation $Cal\ m^{-2}\ y^{-1} \times 10^8$	=	12.6
3.	Phytoplankton photosynthesis production		
	i) $g\ C\ m^2\ y^{-1}$	=	329.2
	ii) $Cal\ m^2\ y^{-1} \times 10^5$	=	31.6
4.	Macrophytic biomass production		
	i) $g\ C\ m^2 y^{-1}$	=	2555
	ii) $Cal\ m^2\ y^{-1} \times 10^5$	=	245.6
5.	Photosynthetic efficiency (%)		
	i) Phytoplankton	=	0.251
	ii) Macrophytes	=	1.9%
6.	Fish Production		
	i) $kg\ ha^{-1}\ y^{-1}$	=	446
	ii) $g\ m^2\ y^{-1}$	=	44.6
	iii) $Cal\ m^2\ y^{-1}$	=	53520
7.	Conversion efficiency (%)		
	i) Total primary production to fish	=	0.193
	ii) Light energy to fish	=	0.002

Some phytoplankton production profiles have been studied in two beels at the pelagic site. In Garapota beel the maximum surface carbon fixation of 578 mg C m^3 hr^{-1} dropped to 125 mg C m^3 hr^{-1} at the 5 m depth zone, when the secchi disc transparency was only 2.75 m. Similarly in Mogra, profile studies showed that surface production of 250 mg C m^3 hr^{-1} declined to 94 mg C m^{-3} hr^{-1} at the 5 m depth zone, with transparency of 4.5 m.

ii) Energy Conversion

The energy conversion estimates in two beels differed markedly. In case of Garapota beel, phytoplankton production was estimated at 47.3 X 10^5 cal m^{-2} y^{-1} recording a photosynthetic efficiency of 0.375%. Macrophytes fixed carbon equal to 114.6 X 10^5 cal m^2 y^{-1} recorded a photosynthetic efficiency of 0.91%. Out of the available energy the fish was able to fix only 38160 cal m^2 y^{-1}. This gave a corresponding conversion of 0.235% to 0.003% from total photosynthesis and light energy to fish.

In case of Mogra beel, 31.6 X 10^5 cal m^2 y^{-1} of energy was fixed by phytoplankton, recording a photosynthetic efficiency of 0.251%. Macrophytes in the system fixed 245.6 X 10^5 cal m^2 y^{-1} of energy with a photosynthetic efficiency of 1.9%. Fish harvest only accounted for 53520 cal m^2 y^{-1}, showing a conversion efficiency of 0.19% between total photosynthesis and fish, and 0.002% from light energy to fish. The energy transfer studies indicate that there is a scope to increase the conversion efficiency at the tertiary trophic level by proper stock manipulation and other fishing management techniques.

PROJECT FC/A/6

ECONOMICS OF FISHING - A CASE STUDY OF SELECTED RESERVOIRS

Personnel : S. Paul, V.V. Sugunan, H.K. Sen

Duration : 1983-1991

Location : Barrackpore

Six reservoirs from the states of Maharashtra and Tamil Nadu were included for the study. The low productivity per fisherman was reflected in lower incomes ranging from Rs.800/- (Upper Aliyar Dam, Tamil Nadu) to Rs.8,683/- (Bhatghar, Maharashtra). Based on certain assumptions, incomes for 1990 and 2000 A.D. were also projected. On the basis of available information/data, it was felt that massive effort in terms of research and development support was necessary to pull out the fishermen from the state of under-employment and low income.

PROJECT **FC/A/7**

ECOLOGY AND FISHERIES MANAGEMENT OF FRESHWATER RESERVOIRS

Personnel : B.V. Govind (upto 31.12.88), Y. Rama Rao (from 21.1.89), A.K. Laal (from 16.1.89), D.S. Krishna Rao, P.K. Sukumaran, M.F. Rahman (Bangalore), P.L.N. Rao, M.D.Pisolkar, B.K. Singh, V. Kolekar (Pune), V.R. Desai, Dhirendra Kumar, N.P. Srivastava, K.K. Agarwal, H.C.Banik (Raipur), G.K. Bhatnagar, H.P. Singh, K.L. Shah,D.K. Kaushal, V.K. Sharma (Bilaspur).

Duration : 1987-1992

Location : Bangalore, Pune, Raipur, Bilaspur

1. Krishnarajasagar (Bangalore)

i) Water level, inflow and outflow :

The water level during the period April to October 1988 fluctuated between 24.11 m (June) and 37.43 m (October). The reservoir registered maximum water level only this year as compared to the previous three years owing to heavy rains in the catchment area. The inflow of water was maximum in August (8207.39 cusecs) and minimum in April (260.37 cusecs). Period from July to September received 75.3% of the inflow. The total inflow during the period was 28570.76 cusecs.

ii) Physico-chemical characteristics of the water

Water samples were collected from three stations namely near the dam, Sagarakatta and Maligere. Water temperature ranged from 24.0°C to 28.2°C. pH ranged from 7.4 to 7.8. pH was alkaline (7.8) in July when the water level was low. The reservoir started receiving inflow from August resulting in decrease of pH to 7.4 in August. Transparency was low in July and August (45 cm & 50 cm respectively) and increased to 225 cm in September. Alkalinity and hardness values were higher in July when the water level was low (100 mg l^{-1} and 174 mg l^{-1} respectively). But these values declined till September and then gradually increased. Dissolved oxygen values ranged from 6.0 to 8.0 mg l^{-1} and no definite trend was noticed in fluctuation. Phosphate and nitrate values were recorded in traces. Silicate values were more or less uniform (0.5 to 0.54 mg l^{-1})

iii) Plankton

Zooplankton always dominated over phytoplankton. The plankton ranged from 0.01 to 2.0 mg m^{-3} and the total counts from 145-450 X (1000) m^{-3}. Generally, the phytoplankton population was very poor. The qualitative composition of plankters was : *Ulothrix, Cosmarium, Oedogonium, Ankistrodesmus, Spirogyra, Pediastrum, Keratella, Filinia, Brachionus, Diaptomus* and *Cyclops.*

iv) Benthic and littoral fauna

The benthic fauna was represented by molluscs and the average number and weights were 933 units m^{-2} and 284.44 g m^{-2} respectively. The genera encountered were *Melania* and *Corbicula.*

The density of littoral fauna ranged from 2 to 933 units m^{-2} in number and 0.082 to 817.78 g m^{-2} by weight. The organisms encountered in the samples of littoral region included nymphs of mayfly, damsel fly, dragonfly, *Notonecta glauca, Diplonychus rustricum* and *Cybister limbatus;* Molluscs - *Anisus convexiusculus, Planorbis exustus, Bythinia stenothyroides, Melania striatella tuberculata, Lymnea accuminata, Viviparus bengalensis, Corbicula peninsularis* and *Lamellidens marginalis;* Fish - *Puntius sophore, Glossogobius giuris* and *Oxygaster* spp. and Prawn - *Macrobrachium* spp. and *Caridina* spp.

v) Aquatic plants

Hydrilla and *Vallisneria* were present sporadically in the marginal areas near the dam site while Salvinia was found near Sagarkatte and Chunchunkatte areas.

vi) Fish landings

The total landings for the period April to July 1988 were 24.7 tonnes. The composition of the yield was major carps - 0.62%, common carp - 53.97%, resident carps - 6.62%, murrels - 5.21%, cat fishes - 8.85% and forage fishes - 24.70%. Very low contribution of major carps to the landings indicated that the stocking of fingerlings of major carps was very low (Table 1).

vii) Fish stocking

A total of 41,200 fingerlings of major carps were stocked in the reservoir by the Fisheries Department in 1988-89. Whereas in previous year 80,000 fingerlings of major carps, 65,000 of common carp and 3,000 of grass carp had been stocked (Table 2).

TABLE - 2. FISH SEED STOCKING IN KRISHNARAJASAGAR RESERVOIR FOR 1987-1988

Period	Major carp	Common carp	Grass carp
1986-1987	-	75,000	-
1987-1988	80,000	65,000	3,000
1988-1989	41,200	-	-

2. BHATGAR RESERVOIR, PUNE

The average reservoir level of Bhatgar was found to be 612.64 m. The minimum level was recorded during the month of June (591.52 m) while the maximum was in the month of October (625.35 m). More than 50% of the rainfall was in the month of July (548.0 mm). The maximum inflow into the reservoir was 6468 cusecs during July and a minimum of 105.57 cusecs in October. The outflow ranged between 10 cusecs and 2382.68 cusecs with an average of 1035.87 cusecs mainly for hydel power generation.

Primary productivity

Primary productivity estimates were made by the use of light and dark bottle technique. Gross productivity varied between 20.83 and 104.16 mg C $m^{-3}hr^{-1}$. The net productivity ranged between 15.62 and 41.66 mg C m^{-3} hr^{-1} in the lentic zone.

Plankton

The following species of phyto- and zoo plankton were encountered in the analysis.

Phytoplankton

i) *Chlorophyceae* : *Pediastrum, Ulothrix, Microspora, Protococcus, Spirogyra, Chaetophora* etc.

ii) . *Bacillariophyceae* : *Tabellaria, Diatoma, Navicula, Surirella, Amphora, Nitzchia, Epithemia, Pinnularia* etc.

iii) *Myxophyceae* : *Microcystis, Anabaena, Nostoc, Oscillatoria, Spirulina, Merismopedia.*

Zooplankton

i) *Rotifers* : *Filinia, Brachionus, Keratella, Asplanchna , Polyarthra.*

ii) *Copepods* : *Cyclops, Diaptomus,* and nauplii.

iii) *Cladocerans* : *Bosmina, Alona, Chydorus, Moina, Diaphnosoma, Macrothris, Daphnia,* and *Ceriodaphnia.*

iv) *Protozoans* : *Difflugia, Ceratium, Euplotis* and *Eudorina*

Periphyton

Samples collected from the submerged rocks revealed species of *Navicula, Synedra, Tabellaria, Oscillatoria, Fragillaria* and *Closperiosis.*

Food and feeding habits

Qualitative analyses of different carps from the reservoir revealed the following items:

TABLE - 1. FISH YIELD IN KRISHNARAJASAGAR RESERVOIR FOR 1987-88 (in tonnes)

Fish Species	Apr. 87	May 87	June 87	July 87	Aug. 87	Sept. 87	Oct. 87	Nov. 87	Dec. 87	Jan. 88	Feb. 88	Mar. 88	Apr. 88	May 88	June 88	July 88	Total	%
MAJOR CARPS (Catla, Rohu, Mrigal)	0.10	0.15	0.08	0.04	0.16	0.11	0.05	---	-----	0.02	0.05	0.10	0.04	0.05	0.05	0.03	1.03	0.35
INDIGENOUS *(Puntius carnaticus, P. dubius, P. sarana Labeo calbasu, L. Fimbriatus & others)*	8.77	10.03	9.07	8.56	8.02	1.40	1.30	1.52	1.44	2.10	1.40	1.76	0.07	0.05	0.85	0.75	61.90	21.14
EXOTIC CARP S *(Cyprinus carpio)*	10.52	27.54	12.59	10.08	10.79	3.28	2.53	2.83	2.50	3.60	3.42	2.80	9.16	2.01	2.26	1.25	107.16	36.60
MURRELS *(Channa marulius, C. striatus)*	1.75	1.80	0.60	0.50	0.60	0.08	0.07	0.10	0.05	0.11	0.12	0.15	0.28	0.21	0.89	0.04	7.35	2.50
CAT FISHES *(Wallago attu, Mystus eenghala, M. punctatus, M. cavasius)*	8.00	12.00	1.50	1.00	0.90	0.55	0.35	0.15	0.20	0.15	0.14	0.11	0.15	0.16	1.50	0.60	27.46	9.38
FORAGE FISHES *(P. ticto, P. conchonius, R daniconius, Oxygaster spp., Glossogobius giuris & others*	36.00	22.00	2.00	1.00	2.00	1.60	1.10	4.20	3.50	2.20	2.30	2.50	3.60	1.25	1.02	0.85	87.92	30.03

i) ***Puntius kolus*** *: Epithemia, Amphora, Surirella, Synedra, Tabellaria, Diatoma, Eudorina, Spirogyra, Dipnoleis* and *Mastogloia.* Occasionally plant seed and sand were also noticed.

ii) ***Chela sp.*** *: Microcystis, Synedra, Tetraspora, Spirogyra, Navicula, Diatoma,* rotifers and copepods.

iii) ***C. catla*** *: Pinnularia,* Diatoms and detritus.

iv) ***C. fulungee*** *: Tabellaria, Navicula, Cosmarium, Epithemia, Synedra, Amphora, Spirogyra* and *Euasterium* etc.

Length-weight relationship of *Puntius kolus* was studied and the same can be expressed as :

$\log W = -7.4083 + 4.0330 \log L \quad r = 0.9991.$

The physico-chemical characteristic features of the water and soil of reservoir are given below :

Water :

i)	*Temperature :*	-	-	17.0 to 27.25°C
ii)	*Transparency :*	-	-	25 cm to 198.5 cm
iii)	*pH :*	-	-	6.25 to 8.26 ppm
iv	*D.O. :*	-	-	6.16 ppm to 8.8 ppm
v)	Free CO^2 :	-	-	1.6 ppm to 3.2 ppm
vi)	*Alkalinity :*	-	-	20.0 to 34.0 ppm
vii)	*Conductivity :*	-	-	46.1 to 84.25 ppm
viii)	*TDS :*	-	-	23.1 to 36.25 ppm
ix)	Phosphates :	-	-	0.280 ppm during Dec.

Soil :

The texture of the soil was somewhat loamy with maximum percentage of silt (75%) followed by clay (18.0%) and sand (7.0%). The average pH was 7.5, organic carbon 0.41% and available phosphorus 2.0 mg 100 g^{-1}.

FISH LANDINGS

A total of 12,471.50 kg of fish were landed from Bhatgar reservoir. *Chela* spp. accounted for maximum percentage (43.16%) with the following species in order of their

abundance : *C. fulungee* (36.63%), *P. kolus* (8.84%), *C. mrigala* (5.76%), *W. attu* (3.35%), *Tor khudree* (0.67%), *C. catla* (0.34%), *Ophiocephalus* sp. (0.31%), *L. rohita* (0.13%), Miscellaneous fishes (0.11%) and *M. seenghala* (0.08%).

A total of 144 gill net units were in operation resulting in a catch of 157.25 kg of fish. The catch per net per day was estimated to be 1.092 kg. The percentage of catch as per their dominance was as follows : *Chela* spp. (52.94%), *P. kolus* (16.66%), *C. fulungee* (9.54%), Miscellaneous fishes (8.90%), *Catla catla* (5.41%), Murrels (3.18%), *W. attu* (2.67%), *P sarana* (0.60%) and *C. reba* (0.10%).

BREEDING & RECRUITMENT

The shooting net operations from Pasure creek (Intermediate zone) revealed the occurrence of fingerlings of *C. mrigala* and *C. fulungee* at a distance of about 12 kilometers from the dam site. Oozing males and spent females were encountered in the gill net catches both from nearer the dam site and the lotic zone of the reservoir.

STOCKING

While fry of mahseer, *Tor khudree* (5,000 Nos.), obtained from Lonavala were stocked during September, 1987, 2.25 lakhs of fingerlings (65-110 mm) of major carps *C. catla, L. rohita* and *C. mrigala* were stocked in the reservoir during the period August-September, 1988.

FISH FAUNA

In addition to the list of 36 species of fishes enlisted from this reservoir, the following five more were added : *C. fulungee; L. potail; P. takree; D. devario* and *Garra* spp.

3. RAVISHANKAR SAGAR RESERVOIR, M.P.

The inflow record of the reservoir showed that it receives water from Murumsilli and Dudhawa reservoirs as and when required for irrigation. Due to this reason, the Gangrel reservoir exhibited continuous process of rising and receding phases. The reservoir water requires stagnancy to gain biotic and abiotic productivity. The ecology and the fishery of Gangrel is thus likely to be affected by the draw-down of water from Dudhawa and Murumsilli reservoirs.

The average reservoir water level of 1988-89 was 338.8 m against 339.5 m of 1987-88, being slightly lower due to subdued rainfall of 96 cm in 1988-89 against 104 cm of 1987-88. Due to low water level of this year, its variation was also lesser (2.37 m) than that of previous year (7.14 m).

Plankton

The plankters estimated from three sampling centres at north, south and centre positions were found to be 845, 475 and 282 units/litre respectively. This trend has given some indication that plankton was more on North bank, as favoured by its depth, being shallower than that of South bank. The plankton was mainly contributed by zooplankton (90.0%), represented by *Diaptomus, Cyclops, Daphnia, Ceriodaphnia, Moina, Keratella, Brachionus* and *Filinia*. The phytoplankton (10.0%) was constituted by *Microcystis, Spirogyra, Pediastrum, Navicula, Gyrosigma* and *Fragilaria*.

Biology of fish

Since *M. aor, M. seenghala* and *C. mrigala* formed the main fisheries of reservoir, the biological studies of these three species were initiated.

(i) Mystus aor : This species contributed 44.0% to total and 86.0% to catfish landings. As seen from the 'condition' of food and gastrosomatic indices (GSI = 0.96-1.11), the feeding intensity slightly declined in the quarter, April-June as against that of January-March (GSI = 1.05-1.26) due to breeding activity (Gonadosomatic index = 2.16-2.94 against 0.35-1.93 of January-March). Due to this variation in feeding and breeding, the relative condition (Kn) of fish, which increased from January-April (0.98-1.15), dropped in May-June (1.01-1.05). Most of the mature fish were found in the size range of 430-545 mm from which it was concluded that the fish probably attained first maturity at 430 mm, which was also supported by the low value of relative condition at this length. The fish mainly subsisted on fish (94.0%), prawns (5.5%) and insects (0.5%). The length-weight relationship of this fish can be expressed by the following equation :

$$\text{Log } W = -4.7148 + 2.8352 \text{ Log } L \quad (r = 0.99).$$

(ii) Mystus seenghala : This fish made up 2.56% in total and 5.00% in catfish landings. During April to June, the fishes studied were in the size range of 461-823 mm (weight range : 0.55-3.00 kg). As seen from higher gonadosomatic index of this period (0.18-0.44) against that of January-March (0.14-0.18), this species also seemed to breed in summer months, although the mature fish could not be examined to support and elaborate this observation. The fish mainly fed on fish (94.3%) with little preference for prawns (5.7%) and the fish diet was composed of the weed fishes such as *Puntius* spp., *Osteobrama* spp. and *Ambassis* spp. The mean length of this fish in the catch was 615 mm.

(iii) Cirrhinus mrigala : Among the major carps, this species accounted for 8.8% in total and 25.5% in carp landings. Only 15 specimens of this fish in the size range of 465-675 mm, (weight range : 1.0-4.2 kg) were examined for biological study from April to June. The fecundity (540-675 mm in total length) was found to range from 2,63,467 to 7,90,417 with the mean mode ova diameter of 1.31-1.40 mm. The diet of the fish mainly consisted of mud (56.3%), organic detritus (27.9%) and plankton (14.4%) with casual occurrence of nematodes (1.4%). The planktonic food was chiefly constituted by diatomic forms such as *Navicula, Gyrosigma, Synedra, Surirella, Fragilaria* and *Gomphonema* and a protozoan - *Difflugia*. The preliminary examination of fish scales for age/growth study has revealed that the commercial catch of this fish was represented by III-IV age groups.

Fish catch statistics

Fish yield data from the reservoir, collected from State Fisheries Corporation for the period April 1988 to January 1989, are given in Fig. 1. According to this information, a total fish catch of 15,870.0 kg was landed from the reservoir in 134 days of fishing against 13,170 kg of 1987-88 (237 days). The production per hectare of this year was found to be 2.5 kg against 2.0 kg of the preceding year. The improvement in fishery of this year was also noticed from the catch/day which was 118.0 kg against 55.0 kg of last year. The catch of November-December (3090.0-4581.0 kg) was the record production in the past two years because the earlier maximum yield of 2814.0 kg was obtained in April 1987.

Thus in the overall fish composition of the year (Fig.2), catfish (51.0%) was the most important in which the fishery of *M. aor* (44.0%) was outstanding. The carp group which contributed 34.0% to the total fishery this year also had an edge over that of last year (23.0%). The improved catches of major carps, observed this year, might be due to the effect of stocking so far done in the reservoir. The miscellaneous fish which constituted 32.0% to the total fishery of last year, declined this year (15.0%).

Stocking

The reservoir is being regularly stocked by State Fisheries Corporation with the major carp fry procured from three Chinese hatcheries of Raipur and Durg districts. Though the stocking was initiated from 1983, the breakup of the species was available only from 1986. The stocking programme is usually undertaken from September-October to December-January during the financial year (Table 3).

Based on the above data and taking into consideration the average productive area of the reservoir (6380 ha), the stocking rate has been calculated to be 250 fry/ha/annum with the ratio of Catla (2), rohu (5) and mrigal (3). Mrigal fishery improved after stocking.

FIG.1 TOTAL LANDINGS IN KG

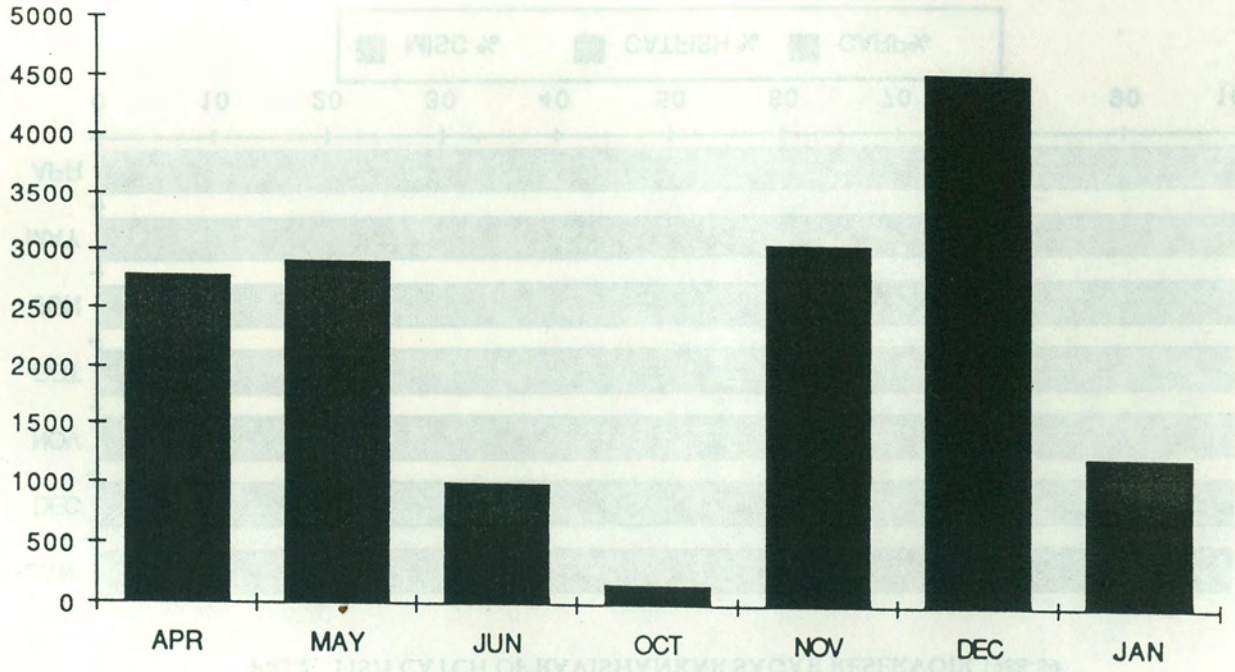


FIG.2 FISH CATCH OF RAVISHANKAR SAGAR RESERVOIR 1988-89

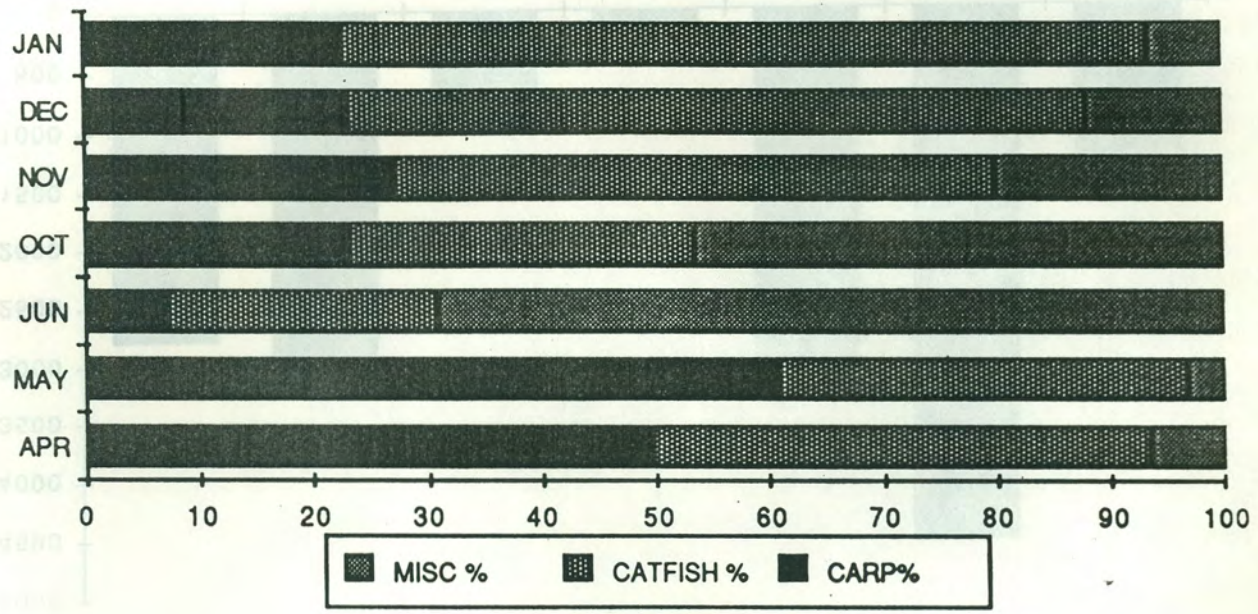


TABLE - 3 . STOCKING FIGURES OF CARPS IN GANGREL RESERVOIR (1986-88)

Year	Month	*C. catla*	*L. rohita*	*C. mrigala*	Total
1986	October	36,000	1,80,000	1,44,000	3,60,000
	Novemaber	44,600	1,36,700	2,34,700	3,16,000
	December	99,700	7,66,700	5,63,600	14,30,000
		1,80,300	10,83,.00	8,42,300	21,06,000
		(8.56 %)	(51.44 %)	(40.00 %)	
1987	January	-	15,000	15,000	30,000
	October	5,02,350	3,27,600	1,20,850	9,50,800
	November	1,40,000	57,000	3,000	2,00,000
	December	56,350	16,100	8,050	80,500
		6,98,700	4,15,700	1,46,900	12,61,300
		(55/39%)	(32.96%)	(11.65%)	
1988	September	2,18,000	2,62,000	-	4,80,000
	October	25,000	2,20,900	2,85,100	5,31,000
	December	1,18,820	2,41,235	93,645	4,53,700
		3,61,820	7,24,135	3,78,745	14,64,700
		(24,70%)	(49.44%)	(25.86%)	
1986-88		12,40,820	22,23,235	13,67,945	48,32,000
		(25.68%)	(46.01%)	(28.31%)	

With a view to ascertaining the yearly trend of developing major carp fishery and its response to the environment, the mean weights of *C. catla, L. rohita* and *C. mrigala* were also calculated every month from November 1986. Estimated age and size groups based on the mean weight are presented in table 4 which clearly indicates that the catch of major carps comprising II to IV year group.

TABLE - 4. Mean weights and estimated lengths/ages of major carps from Gangrel

Species	Mean weight	Estimated	
	(kg)	Size range (mm)	Age group
C. catla	4.0 - 9.0	600-700	2-3
L. rohita	1.0 - 3.5	400-600	3-4
C. mrigala	1.0 - 2.0	400-500	3-4

4. GOVINDSAGAR RESERVOIR, BILASPUR, H.P.

Water level, inflow and outflow

The water level of the reservoir during the period April to December 1988 fluctuated by 50.78 m from a minimum of 463.24 mm (April) to a maximum of 514.02 m (September). The total inflow during the period was 20,33,020 ha m. The total outflow during the period was 16.13,786 ha m.

Meteorological observation

The water temperature at tail race fluctuated between 17.8°C (December) and 23.13°C (August). The total rainfall during the period was 1885.8 mm. Atmospheric temperature varied from 40.57°C (May) to 10.80°C (December).

Plankton

The average plankton for whole of the reservoir was estimated at 867 u l^{-1} with 1.16 ml m^{-3}. This indicated decline in the population compared to that of 1631 u l^{-1}; 2.00 ml m^{-3} during the period April to December 1987.

Qualitatively, phytoplankton were recorded to be dominant over zooplankton. *Ceratium* and *Rhizoclonium* dominated during the period April-June while *Ceratium* and *Synedra* were abundant during the speriod July-September. Other common forms encountered were *Peridinium, Staurastrum, Pediastrum, Cyclotella, Botryococcus, Microcystis, Navicula, Gomphospheria* and diatoms. Nauplii and *Cyolops* dominated the zooplankton followed by *Keratella, Brachionus* and *Hexarthre.*

Macrobenthos

The average standing crop for whole of the reservoir was estimated at 339 units per 1.51 g m^{-2}. This indicated decline in the population of benthos than that of 581 units per 15.95 g m^{-2} during the period April to December, 1987.

Qualitatively, lotic zone was dominated by dipteran larvae *(Chironomus, Chaoborus)* whereas lentic and Lunkhar Khad (bay) were dominated by oligochaetes *(Branchiura, Limnodrilus, Tubifex, Nais)* followed by dipterans *(Chaoborus, Chironomus)* and molluscs *(Sphaerium).* Ephemeropteran larvae *(Ephemera)* occurred in Lentic zone.

The annual average bathymetric distribution of benthos showed their maximum concentration at 4 m depth in lotic zone. Lentic zone showed the benthos abundance at 8 m. and at 40-50 m depth. In Lunkhar Khad, the fauna showed their abundance at 8-15 m and at 50-60 m depth.

Periphyton

Studies of periphytic communities showed that Bacillariophyceae remained the dominant flora both qualitatively and quantitatively. On an average, Bacillariophyceae formed 75.6% of the periphytic communities followed by Chlorophyceae (14.7%).

The dominant periphytic organisms encountered during the period were *Cymbella, Navicula, Tabellaria, Gomphonema, Nitzschia, Synedra, Coloneta, Chaetophora, Cladophora, Characium, Charciopsis, Difflugia* and *Vorticella.*

Age and growth

The age and growth of various fishes of the Gobindsagar were studied by examining the scales. The Von Bertalanffy's growth equations derived for various fishes during the period are as follows :

1. *Catla catla* : $Lt = 1726\ (1-e^{-0.0749(t+1.0707)})$
2. *Labeo rohita* : $Lt = 1309\ (1-e^{-0.0551(t + 4.2913)})$
3. *Cirrhinus mrigala* : $Lt = 1666\ (1-e^{-0.0747\ (t + 1.5765)})$
4. *Cyprinus carpio* : $Lt = 1622\ (1-e^{-0.0592\ (t + 1.0650)})$
5. *Ctenopharyngodon idella* : $Lt = 2093\ (1-e^{-0.0723\ (t + 1.5641)})$
6. *Tor putitora* : $Lt = 1593\ (1-e^{-0.0775\ (t + 1.1581)})$
7. *Puntius sarana* : $Lt = 488\ (1-e^{-0.0983\ (t + 2.2274)})$

Fish yield

The fish landing records showed that 562.7 tonnes of fish were landed during the period April to December 1988. Thus, a gross yield of 619.0 tonnes was estimated at the rate of 54.78 kg /ha/9 months of fish production, after considering 10% of the total landings as poaching and spoilage. Thus, the fish production increased by 52.09% compared to 407.0 tonnes of landings during the period April to December 1987.

H. molitrix dominated the catch forming 77.92%. The catch of silver carp also increased as compared to 61.53% in the period April-December 1987. *C. carpio* constituted 9.90% of the total catch followed by *C. catla* (4.57%), *T. putitora* (4.16%), *L. dero* (21.91%), *L. rohita* (0.56%), *C. mrigala* (0.29%), *M. seenghala* (0.20%) and *L. calbasu* (0.17%).

The period from 16.6.1988 to 15.8.1988 was observed as closed season for fishing. Seasonal variations in the catch were evident during the period May-June, with highest landings of 208.3 tonnes (37.02%). The minimum landing of 35.3 tonnes was recorded in the month of November.

Zone-wise landings showed that maximum fish were landed at Bhakra Centre (lentic zone), forming 69.28% of the total catch from the reservoir.

PROJECT FC/A/10

ECOLOGY AND FISHERIES OF THE SMALL RESERVOIR IN ALIYAR BASIN (MISSION PROJECT)

Personnel : C. Selvaraj, V.K. Murugesan, R.C. Singh (from 19.11.1988)

Duration : 1985-1990

Location : Coimbatore/Aliyar Nagar

The water level in the reservoir decreased from 25.52 m in April to 18.2 m in July and then gradually increased till November only to decline in December. While the total inflow during April to July ranged from 79.89 to 191.08 cusecs, the total outflow during the same period ranged from 97.64 to 289.31 cusecs. The total outflow during December (505.664 cusecs) was more than the inflow (257.558 cusecs).

Meteorological Studies : The air temperature at Aliyar Nagar ranged from 37.5°C (April & May) to 15.0°C (December). The maximum rainfall was recorded in May (192.6 mm) followed by April (121.4 mm) and July (110.5 mm). Although, there was scanty rainfall in all the other months under report, the total rainfall for the period (684.4 mm) was not considered adequate.

Recruitment : Studies made on the maturation of fishes landed through commercial fishing and observations on the shore-collections at Aliyar reservoir further confirmed that the Indian and exotic major carps do not attain sexual maturity and that no spawning or recruitment occurs in the reservoir, indicating that the fishery of the reservoir has to depend solely on the quality and quantity of seed stocked every year from extraneous sources.

Growth of Silver carp : Out of 5,031 silver carps stocked during 1987, 100 fish were harvested through commercial fishing during April to December, 1988. In the commercial catch, the total length ranged from 570 to 890 mm and weight 2250 to 7500 g.

Clipping : Out of 500 catla, 500 rohu, 650 mrigal and 600 common carp released in the reservoir during December, 1987 to February, 1988 after clipping the left-pelvic fin, 7 catla, 2 mrigal and 88 common carp were recovered from the reservoir with marks of pelvic fin clipping. The number of specimens recaptured in different species through months and their size range and mean are presented in Table 1.

TABLE - 1. DETAILS OF RECOVERY OF CLIPPED FISH FROM ALIYAR RESERVOIR DURING APRIL TO DECEMBER, 1988

Month	Species	Nos.	Total length (mm)		Total weight (g)	
			Range	Average	Range	Average
April	*C. catla*	1	460	460.0	1300	1300.0
May	*C. carpio*	1	275	275.0	600	600.0
June	*C. catla*	2	415-460	437.5	800-1300	1050.0
	C. carpio	27	275-450	378.9	600-1750	959.3
July	*C. mrigala*	1	600	600.0	1300	1300.0
	C. carpio	4	305-380	332.5	750-1250	962.5
August	*C. catla*	2	360-480	420.0	1000-1700	1350.0
	C. carpio	24	210-410	349.0	800-1500	1187.5
September	*C. carpio*	13	369-430	397.9	950-1500	1224.5
October	*C. carpio*	10	330-498	403.3	950-1600	1155.0
November	*C. catla*	1	457	457.0	1500	1500.0
	C. carpio	5	420-490	453.0	1400-2100	1700.0
December	*C. catla*	1	440	440.0	1000	1000.0
	C. mrigala	1	420	420.0	600	600.0
	C. carpio	4	442-520	481.0	1700-3000	2025.0

The regeneration of clipped pelvic fins was low (43.75%) in *C. catla*, whereas it was more in *L. rohita* (85.0%) and *C. mrigala* (82.35%). The pattern of regeneration in the specimens in different species varied in the shape, number of fin rays, length, etc. from unclipped ones.

Further observations on the course of treatment for healing of wound caused by marking conclusively proved that the wound should be first cleaned thoroughly with the help of hydrogen peroxide to remove the debris and then wip with dried surgical cotton to remove slime and wetness for easy adherence of the drug on the wounded area. Application of furacin ointment on the wounded area was found to be effective in healing of the wound in about 7 to 10 days.

Fish yield and reservoir management : A total of 38,203 kg of fish was harvested from the reservoir through commercial fishing of which the contribution due to major carps stocked in the reservoir by the centre was 94.72% and the rest 5.28% was due to medium and minor carps, predatory fishes and other uneconomical miscellaneous fishes. Among the major carps, *C. catla* contributed the maximum (53.8%) followed by *C. carpio* (17.02%), *C. mrigala* (11.87%), *L. rohita* (10.9%) and *H. molitrix* (1.13%). The details regarding fishing effort, CPUE and average daily catch are given in Table 2. The average catch 17.09 kg day^{-1} was almost 100% more than that of last year (9.05 kg day^{-1}). At the present rate of exploitation of 4,275 kg $month^{-1}$, the yield from the reservoir amounts to 157.2 kg $ha^{-1}annum^{-1}$, an excess of 7.2 kg ha^{-1} $annum^{-1}$ which is more than the target (150 kg ha^{-1} $annum^{-1}$) fixed for the Mission Project.

Fish seed production and stocking

Brood fish maintenance : The Indian and exotic carp brood fish were stocked in two rearing ponds of 0.1 ha each at the rate of about 2,000 kg ha^{-1}. The ponds were fertilized every 15-30 days interval with lime and organic fertilizer. The quality of water was monitored at weekly intervals. Infection of *Argulus* sp. was noticed due to frequent fertilization of ponds and regular feeding of brood fish. In spite of several treatments of brood fish with salt solution, potassium permanganate solution, gammaxane, etc., the ectoparasite persisted and some of the brood fish could not attain full sexual maturity. However, a few specimens which attained maturity were induced by hypophysation. A total of 12,058 lakhs of spawn of all the species together was produced during the breeding season, of which 5,608 lakhs of spawn were stocked in the eight nursery ponds of 0.01 ha each for raising fry/fingerlings for stocking in the reservoir and 6.45 lakhs of spawn were handed over to Tamil Nadu Fisheries Development Corporation Limited.

TABLE - 2. SPECIES-WISE FISH YIELD DURING APRIL-DECEMBER 1988 (kg)

Species	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	% Contribution
C. catla	1261.75	1342.75	1688.75	1781.95	2380.10	1245.25	3883.95	4299.75	2670.55	20554.80	53.80
L. rohita	705.50	390.00	901.00	716.50	566.40	210.50	332.60	190.75	150.25	4163.50	10.90
C. mrigala	474.50	379.25	679.25	731.50	839.95	415.80	406.60	389.25	220.25	4536.35	11.87
C. carpio	1019.75	539.00	1005.00	591.50	615.35	494.25	879.75	729.80	628.85	6503.25	17.02
H. molitrix	90.25	60.25	17.50	65.25	42.25	27.25	18.45	60.25	51.00	432.45	1.13
L. fimbriatus	-	-	-	24.25	38.00	14.65	20.50	11.50	8.40	117.30	0.31
Channa sp.	-	-	-	-	-	-	2.00	-	-	2.00	-
T. mossambica	1097.75	151.50	71.75	22.75	52.15	59.65	35.20	151.00	245.75	1887.50	4.94
Misc.	-	-	-	-	-	3.70	2.75	-	-	6.45	0.02
Total :	4649.50	2862.75	4363.25	3933.70	4537.90	2470.10	5579.05	5832.30	3975.05	38203.60	
No. of units operated	216	248	240	229	248	240	266	270	279	2236	
Catch per unit effort (kg)	21.53	11.54	18.18	17.18	18.30	10.29	20.97	21.60	14.25	17.09	
Average daily yield (kg)	166.00	94.35	145.40	131.12	146.35	82.34	185.97	194.41	128.44		

TABLE - 3. FINGERLINGS STOCKED AND FISH RECOVERED DURING APRIL-DECEMBER, 1988

Months	*C. catla*		*L. rohita*		*C. mrigala*		*C. carpio*		Total	
	Stocked	Recovered	Stocked	Recovered	Stocked	Recovered	Stocked	Recovered	Stocked	Recovered
April	-	624	-	410	-	282	-	837	-	2153
May	4976	744	3294	222	17866	186	5492	400	31628	1552
June	312	1111	333	509	-	352	2117	810	2762	2782
July	78	1051	234	445	12	409	1735	444	2059	2349
August	5	1190	172	322	27	403	1620	474	1824	2309
September	2	543	357	128	111	195	525	419	995	1285
October	8066	1164	15108	189	1276	191	2075	778	26525	2322
November	9069	1173	2862	87	1071	183	3039	603	16041	2046
December	2913	705	455	77	815	114	1537	508	5720	1404
Total :	25421	8305	22815	2389	21178	2315	18140	5273	87554	18282
% Recovery :		32.67		10.47		10.93		29.07		20.88

Spawn and fry rearing : The major carp spawn stocked in the nursery ponds (0.01 ha each) were fed daily with a mixture of ricebran and groundnut oil cake at 1 : 1 ratio. At the size range of 15 to 30 mm they were transferred to other ponds (0.1 ha each) for further rearing. At the size of 100 mm they were stocked in the reservoir.

Stocking : Altogether 87,554 fingerlings (more than 100 mm) of Indian and exotic major carps consisting of 25,421 catla, 22,815 rohu, 21:178 mrigal and 18,140 common carp were stocked in the reservoir. The number of fingerlings stocked and the fish harvested from the reservoir during the period are presented in Table 3. The study indicated that the reservoir should be stocked more with catla and *C. carpio*. The average size of fish indicated a maximum growth for *H. molitrix* followed by *C. catla, C. mrigala, L. rohita* and *C. carpio*.

PROJECT **FC/A/12**

ECOLOGY AND FISHERIES MANAGEMENT OF LARGE PENINSULAR TANK

Personnel : B.V. Govind (upto 31.12.1988) and P.K. Sukumaran

Duration : 1987-1990

Location : Bangalore

Nelligudda reservoir (112 ha) near Bangalore was studied. The hydrological parameters were; water temperature 28.2°C, pH 7.8, dissolved oxygen 7.2 mg, free carbondioxide 4.8 mg l^{-1}, methyl orange alkalinity 104 mg l^{-1}.

Plankton

The volume of plankton ranged from 0.1 to 0.4 ml^{-1} and the total counts were between 160 and 640 units l^{-1}. The dominant genera observed were *Microcystis, Ulothrix, Ankistrodesmus, Pediastrum, Arcella, Keratella, Brachionus, Filinia, Bosmina, Diaphanosoma, Diaptomus, Cyclops* and its nauplii.

Littoral fauna

The density of littoral fauna in the impoundment ranged from 1-17 units m^{-2} (0.086-0.473 g m^{-2} by weight). The encountered forms were insects : *Ranatra* and *Laccotrephes;* Prawn : *Macrobrachium,* and fish *(Oreochromis mossambicus).*

Fish composition

By cast netting operations the following fish species were recorded *Puntius sarana* (av. 100 g), *Ompok bimaculatus* (range : 130-150 g) and *Oreochromis mossambicus* (100 g).

Studies on Nelligudda tank were discountinued during the year 1988.

PROJECT **FC/A/13**

A COMPARATIVE STUDY OF PREHARVEST AND POST-HARVEST MANAGEMENT PRACTICES OF SELECTED BEELS OF THE COUNTRY

Personnel : S. Paul, Y.S. Yadava and H.K. Sen

Duration : 1987-1990

Location : Barrackpore

Attempts were made to collect the requisite economic data pertaining to beels in the states of Assam and West Bengal. Available information/data are too insufficient to base a definite finding. However, on preliminary examination beel fisheries seem to provide part-time engagement to fishermen.

PROJECT FC/A/14

ECOLOGY AND FISHERIES MANAGEMENT OF A SMALL RESERVOIR IN GANGA BASIN, BAGHLA RESERVOIR

Personnel : M.A. Khan, D.N. Singh, H.P. Singh, R.K. Dwivedi, R.K. Tyagi and Ram Chandra

Duration : 1988-1991

Location : Allahabad

Baghla Reservoir is located in the Barah Tehsil of Allahabad District, 55 km away from Allahabad city. Constructed on Baghla Nullah in 1952, the reservoir has a water area of about 250 ha. Capacity of the reservoir is 116,585 mm^3 at the FRL of 386' above MSL. The reservoir was taken over by the Institute from the Uttar Pradesh Fisheries Department in November 1988 at a lease value of Rs.16,000/- per annum for a period of 3 years.

Physico-chemical characteristics of water

An examination of the Table 1 reveals that except for dissolved oxygen, no variations are discernible in the physico-chemical parameters. Details of diurnal variation in physico-chemical features of water of Baghla Reservoir in the lentic zone are given in Table 2.

Primary production

The primary organic carbon production was studied by conventional dark and light bottle method in lotic and lentic zones. The gross and net production varied between 75.00 to 125.00 mg C $m^{-2}h^{-1}$, and 50.00 to 87.5 mg C $m^{-2}h^{-1}$, respectively. The respiration rate was found to fluctuate between 30.00 to 45.00 mg C $m^{-2}h^{-1}$. It was also observed that maximum carbon production took place at 1 m depth.

Plankton

The plankton population ranged from 150 u l^{-1} in the lotic sector to 5485 u l^{-1} in the lentic sector during the period of study. Phytoplankton outnumbered zooplankton in the ratio of 3.31 : 1.60. Myxophyceae, Chlorophyceae, Bacillariophyceae, Dinophyceae, copepods, rotifers, cladocerans and protozoan formed 20.42%, 15.98%, 14.21%, 26.31%, 8.0%, 9.95%, 3.98% and 12.5% of the total plankton respectively.

TABLE - 1. PHYSICO-CHEMICAL CHARACTEERISTICS OF WATER OF THE BAGHLA RESERVOIR DURING 1988-89

Months/ dates of collection	Zone	Water temp. °C	Trans-parency (cm)	D. O. mg l $^{-1}$	pH	Specific conduc. µ ngis cm-1	TDS mg l^{-1}	Free CO_2 m g 1^{-1}	CO_3 mg l^{-1}	HCO_3 mg l^{-1}
November	Lentic	-	-	8.80	8.53	82.1	41.3	Nil	16.0	48.0
(3.11.88)	Lotic	-	-	12.80	8.51	78.7	39.5	Nil	16.0	50.0
December	Lentic	21.0	125.0	10.8	8.60	63.0	31.0	Nil	12.0	12.0
(24.12.88)	Lotic	20.5	50.0	12.0	8.68	73.0	36.0	Nil	19.0	50.0
January	Lentic	18.5	150.0	9.6	7.78	74.9	37.5	Nil	10.0	56.0
(27.1.89)		18.5	-	9.6	7.76	72.2	36.2	Nil	10.0	60.0
		18.5	-	9.6	7.76	72.0	36.1	Nil	12.0	62.0
		18.0	-	9.6	7.77	71.3	35.8	Nil	10.0	58.0
	Lotic	19.0	140.0	10.08	7.76	82.0	41.2	Nil	12.0	64.0

contd..

Table 1 contd.

Months/ dates of collection	Zone	Nitrates $mg\ l^{-1}$	Phosphates $mg\ l^{-1}$	Silicates $mg\ l^{-1}$
November	Lentic	0.32	0.28	-
(3.11.88)	Lotic	0.29	0.30	-
December	Lentic	0.36	0.33	-
(24.12.88)	Lotic	0.31	0.31	-
January	Lentic	0.29	0.27	2.5
		0.29	0.27	2.5
		0.31	0.27	2.6
		0.31	0.28	2.6
	Lotic	0.30	0.28	2.4

TABLE - 2. DIURNAL VARIATION IN PHYSICO-CHEMICAL FEATURES OF WATER OF BAGHLA RESERVOIR IN LENTIC ZONE DURING JANUARY 1989

	1200 hrs			1600 hrs			2000 hrs		
	Surface	1m	2m	Surface	1m	2m	Surface	1m	2m
Water temp. °C	19.0	19.0	18.5	19.0	19.0	19.0	18.0	18.0	18.0
Transparency (cm)	145.0	-	-	114.0	-	-	113.0	-	-
Dissolved oxygen mg l^{-1}	9.72	9.6	9.6	10.40	10.08	9.92	9.6	8.48	9.6
pH	7.78	7.76	7.76	7.78	7.78	7.77	7.80	7.79	7.75
Sp. conduc. µmhos cm^{-1}	74.9	72.2	72.0	72.8	72.8	72.0	73.5	73.7	74.0
Total Dissolved solids mg l^{-1}	37.5	36.2	36.1	36.6	36.4	36.1	36.9	37.0	37.1
Free CO_2 mg l^{-1}	nil	nil	nil	nil	nil	nil	nil	nil	nil
Carbonates mg l^{-1}	10.0	10.0	12.0	14.0	10.0	11.0	6.0	6.0	2.0
Bicarbonates mg l^{-1}	56.0	60.0	62.0	58.0	58.0	64.0	59.0	57.0	57.0

contd..

Table 2 contd.

	2400 hrs			04 00hrs			08 00hrs		
	Surface	1m	2m	Surface	1m	2m	Surface	1m	2m
Water temp. °C	13.0	13.0	13.0	12.0	11.0	11.0	17.5	17.5	17.5
Trasparency (cm)	104.0	-	-	11.0	-	-	101.0	-	-
Dissolved oxygen mg l^{-1}	9.60	8.48	9.28	9.44	8.96	8.8	9.12	5.12	8.96
pH	7.79	7.80	7.80	7.80	7.80	7.79	7.79	7.79	7.79
Specific donduc. µmhos cm^{-1}	72.2	72.2	72.0	74.0	73.0	72.9	73.1	73.8	74.1
Total Dissolved solids mg l^{-1}	36.3	36.1	36.1	37.2	36.6	36.6	36.7	37.0	37.2
Free CO_2 mg l^{-1}	nil	nil	nil	nil	nil	nil	nil	nil	nil
Carbonates mg l^{-1}	3.0	3.0	3.0	4.0	2.0	2.0	3.0	3.0	3.0
Bicarbonates mg l^{-1}	54.0	54.0	54.0	52.0	50.0	50.0	56.0	56.0	54.0

Diurnal studies

Data pertaining to diurnal studies (Table 3) revealed that maximum concentration of the plankton (4000 u l^{-1}) was on surface at 16 hrs. This was directly related to high DO value (10.40 mg l^{-1}). The minimum concentration of plankton was observed at 24 hrs. at 3 m depth being 405 u l^{-1} followed by 476 u l^{-1} at 3 m depth at 20 hrs.

TABLE - 3. DIURNAL FLUCTUATION OF PLANKTON (u l^{-1}) IN BAGHLA RESERVOIR IN JANUARY 1989

	1200 hrs	1600 hrs	2000 hrs	2400 hrs	0400 hrs	0800 hrs
Surface	1500	4000	1400	2500	500	2000
1 m	3371	2857	571	2214	2143	2857
2 m	1071	3214	1250	2143	3285	1357
3 m	810	1071	476	405	643	833
Average	1738	2785	924	1815	1767	1361

Phytoplankton was dominated by *Microcystis* and zooplankton by rotifers. The latter depicted maximum species diversity. Six-species were recorded. A positive diurnal movement in respect of *Microcystis* was observed. However, maximum concentration in case of zooplankton was recorded at 0400 hrs. and minimum at 0800 hrs.

Macrobenthic fauna

The benthos population ranged from 665 u m^{-2} in the lotic sector to 1287 um^{-2} in the lentic sector during the period of study. The benthic population was mainly constituted by insect larvae (72.4%) and mollusc (21.5%) followed by annelids (4.2%) and others (2.1%).

Stocking and marking

About 50,000 fingerlings were stocked in the reservoir and about 100 of them were tagged by anchor tags. Fishing rights of the reservoir were leased out for Rs.22,500/- for a year restricting the catch to 6.5 t. Fishing commenced early in March and 50% of the target was already achieved by the middle of the month.

PROJECT FC/A/15

ECOLOGY AND FISHERIES MANAGEMENT OF MUKTAPUR OX-BOW LAKE *(MAUN)* IN GANDAK BASIN (NORTH BIHAR)

Personnel : K.P. Srivastava, B.C. Jha, S.N. Singh (till June 1988)
V. Pathak, V.R. Chitranshi, P.N. Jaitly and C. Lakra

Duration : 1988-1990

Location : Muzaffarpur, Muktapur

Physico-chemical features of the lake

The physico-chemical characteristics of the water quality and their pattern : The water of the lake remained circum-neutral throughout the period under study with pH and alkalinity ranging between 7.8-8.15 and 90.0-116.0 mg l^{-1}, respectively. Fluctuation of CO_2 was in the range of nil - 7.0 mg l^{-1}. Specific conductance (181.0-249.0 micromhos) and total dissolved solids (87-122 mg l^{-1}), were found to be moderately high (Table 1).

A wide range of variation has been observed in respect of the 'diel' cycle of parameters like DO, pH, CO_2, CO_3 and HCO_3. Fluctuation in respect of DO was maximum (1.3-9.9 mg l^{-1}) from morning to evening. Carbonate was found absent in the morning hours on many occasions but showed a sharp increase; as the day progressed attaining the peak (13.0 mg l^{-1}) by noon. On the contrary, bicarbonates showed an inverse correlation with the advancement of time during the day, but the process was reversed at night (Table 1).

TABLE - 1. DATA PERTAINING TO THE ECOLOGY OF MUKTAPUR LAKE

Parameters	Range	Annual av.
Morphometry		
Area (ha)	60	
Mean depth (m)	0.56-5.28	
Physico-chemical		
pH	7.8-8.15	7.97
D.O. (ppm)	1.7-9.9	4.82
CO_2 (ppm)	Nil-7.0	3.29
Carbonate (ppm)	Nil-18.0	4.00
Bi-carbonate (ppm)	90.0-116.0	99.86
Total dissolved solids (ppm)	87.0-122.0	104.00
Sp. conductance (micro mhos)	181.0-249.0	212.00
Primary production		
Total plankton (mgC $m^{-2}day^{-1}$)	134.5-675.0	387.93
Nannoplankton (mgC $m^{-2}day^{-1}$)	115.80-526.50	289.50
Net plankton (mgC $m^{-2}day^{-1}$)	18.72-156.55	98.43
Macrophytes (mgC m^{-2} day^{-1})	2565.0-3465.0	3022.50

Detritus		
Dry weight g m^{-2}	232.8-417.22	284.00
Plankton		
Net plankton (u l^{-1})	505-18605	9555.00
Nannoplankton (u l^{-1})	4890-19269	14524.50
Periphyton (u cm^{-2})	765-1410	1087.50
Macrophytes (wt m^{-2}) in kg	8.21-16.78	12.49
Benthos (No. m^{-2})	2082-6623	4352.50

Primary production

Primary production, (^{14}C method) ranged between 134.52 - 675.0 mg cm^{-2} day^{-1}. About 53.8 - 82.0% of the productivity (115.8 - 526.5 mg cm^{-2} day^{-1}) at this trophic level was through nannoplankton and thus the net plankton accounted for only 18.0 - 46.2% of the primary productivity. Significantly, the primary productivity through macrophytes was much higher, 2565.0-3465.0 mg cm^{-2} day^{-1}, as compared to the production through phytoplankters (Table 1).

Detritus load and the bottom organic deposits

The lake was quite rich in bottom organic deposits and detritus load, 232.8-417.22 g m^{-2}, averaging 284.0 g m^{-2}.

Plankton

Because of the productive nature of the lake, blooming of *Anacystis* sp. and abundance of volvocales were observed. But the condition disappeared soon as indicated by the greater abundance of desmids and *Peridinium* sp. during winter.

Plankton population ranged between 505 u l^{-1} to 18,605 u l^{-1} (July and September respectively). The average ratio between phytoplankton and zooplankton was found to be 1.8 : 1 except in September when the ratio was 75 : 1.

The community structure of plankton showed marked seasonal changes, especially in phytoplankton and thus a definite succession was evident. The post-monsoon months showed the dominance of blue greens (even upto 81.69%) followed by green algae (14.46%), Bacillariophyceae (0.92%) and Dinophyceae (0.05%). The winter months however, showed dominance of Dinophyceae (47.0%) followed by Chlorophyceae (25.4%), blue-greens (15.0%) and diatoms (12.6%).

Among zooplankton, crustaceans contributed the maximum (69.31 to 85.7%) followed by rotifers (8.08 to 14.50%) and protozoans (6.12 to 16.20%). Unlike the phytoplankton, this group did not offer any change in the pattern of abundance from post-monsoon to winter months. However, the qualitative spectrum did show an increasing trend with regard to rotifers and protozoans and decrease in crustacean contributions.

Nannoplankton

The qualitative spectrum of nannoplankton is much smaller as compared to the net plankton but the group is highly significant quantitatively. The population ranged between 4890 u l^{-1} to 19269 u l^{-1} being the highest in June and lowest in July. The community size of nannoplankton appeared to be regulated by the abundance of filamentous bacteria in general and *Chlorobium* sp. in particular. *Thallothrix* sp. was the other dominant filamentous bacterium prevalent in the lake.

The following dominant organisms contributed to the nannoplanktonic spectrum :

Lympocynclis sp.	-	Euglenophyceae
Chreococcus sp.	-	Myxophyceae
Chlamydomonas sp		
Carteria sp	-	Chlorophyceae
Sphaencystis sp.		
Chlorobotrys sp.	-	Xanthophyceae

Cyclotella comta
Achnanthes exigna - Bacillariophyceae

Chlorobium sp
Thallothrix sp. - Filamentous bacteria

Periphyton

The periphytic population showed a gradual increase in its abundance during July to December. Maximum periphyton was recorded in December (1410 u cm^{-2}) and minimum in July (765 u cm^{-2}). The sub-surface strata of the column showed greater assemblage of periphytic communities and with the increase in depth profile, a substantial erosion in the size of the population was evident. The entire column was dominated by diatoms (51.78 to 87.71%) followed by blue-greens (6.34-27.66%) and Chlorophyceae (5.95-20.56%).

Macrophytes

Muktapur lake was highly infested with macrophytes and among them submerged vegetation was the most dominant. The wet weight of hydrophytes ranged between 8.21 kg m^{-2} to 16.78 m^{-2}, being the highest in October and lowest in June. The pattern of weed infestation and the qualitative spectrum of the existing flora were found indicative of a strong ecological succession *viz., floating - submerged - emergent - marginal - floating islands.* The incidence of floating island was high during monsoon which gradually settled towards the margins resulting in loss of water spread area every year.

Dominant macrophytes of the lake (in order of abundance) were : *Hydrilla verticillata, Potamogeton pectinalis, Myriophyllum intermedium, Najas minor, Nelumbo nucifera, Ipomoea aquatica, Ceratophyllum demersum, Eichhornia crassipes,* and *Polysonum barbatum.* Pteridophytic weeds like *Azolla pinnata, Marsilea trifolia* and *Wolffia* sp. were also very common in the lake. Marginal algal weeds, *Chara bruuii* and *Nitella* spp. were also prevalent.

Flora and fauna associated with weeds

Many insects and benthic organisms were found inhabiting the macrophytic niche of the system and among them molluscs were of prime significance. *Lymnaea acuminata* were found attached to the hydrophytic leaves in large numbers.

Macrophyte associated flora were dominated by Bacillariophyceae, blue-greens and filamentous algae.

Bottom biota

The benthic population of the lake was dominated by gastropods to the extent of 96.7%. *Tubifex* and other insect larvae contributed 2-3% only.

Numerical abundance of benthos ranged between 2082 no. m^{-2} to 6623 m^{-2}, the lowest being in July and the highest during June.

Fish and Fishery of the lake

Besides the Indian major carps, *(C. mrigala, C. catla, L. rohita* and *L. calbasu)* and large cat fishes (*M. aor, W. attu),* 37 species of minor carps, small cat fishes, clupeids, perches, murrels, eels, gobids, shrimps etc. were identified.

Total annual fish landing was estimated to be 1205.46 kg, which was contributed mainly by minor carps and smaller group of fishes (82.71%). The major carps and large cat fishes contributed only 9.96% and 7.33% respectively. (Table 2). *Channa marulius* and *Nandus nandus* were the most dominant among the fishes of the lake and only these two fishes accounted for 48.74% of the total landing.

TABLE - 2. TOTAL ESTIMATED ANNUAL SPECIES-WISE FISH LANDING FOR MUKTAPUR LAKE

Species	Catch in kg	Percentage abundance
Catla catla	90.00	7.48
Labeo rohita	18.00	1.49
Labeo calbasu	11.91	0.99
Wallago attu	88.35	6.96
Heteropneustes fossilis	19.80	1.65
Cirrhina reba	83.85	6.96
Notopterus notopterus	15.90	1.32
Notopterus chitala	14.70	1.23

Mystus cavasius	45.45	3.78
Shrimps	55.20	4.58
Channa spp.	258.75	21.47
Puntius sp.	129.60	10.75
Nandus nandus	45.30	3.76
Misc.	328.65	27.27

A negative fishing practice of capturing major carp juveniles of 150-250 mm size prevalent in the lake. A fine-meshed (1/20 - 1/40) drag net, locally called *Chatti jal* is used for this purpose.

Natural recruitment of major carps

Muktapur lake was an open oxbow lake till recently as it was connected with river Burhi Gandak by a narrow channel, but due to the raising of embankment and the regulation of the channel, there is no more flushing of the river water during the monsoon months and as such, no ingress of fish could be observed. In the lake also, no breeding of major carps was observed.

Pen culture experiment

Pen culture experiments were initiated (area 0.08 ha) by stocking them with 750 major carp fingerlings.

Initial length and weight of different stocked species in the lake by erecting a split bamboo pen culture of 0.08 ha and stocking it with 750 major carp fingerlings.

Species	Length range (in mm)	Wt. range (in mm)	Total no. of fingerlings
C. catla	80-165 (122.5)	15-19 (17.0)	250
C. mrigala	60-122 (91.0)	10-12 (11.0)	300
L. rohita	90-120 (105.0)	17-20 (18.5)	250

Ratio - catla : rohu : mrigal - 1 : 1 : 1.5
Figure in paranthesis denotes the average

PROJECT **FC/A/16**

ECOLOGY AND FISHERIES MANAGEMENT OF BEEL IN BRAHMAPUTRA BASIN (ASSAM)

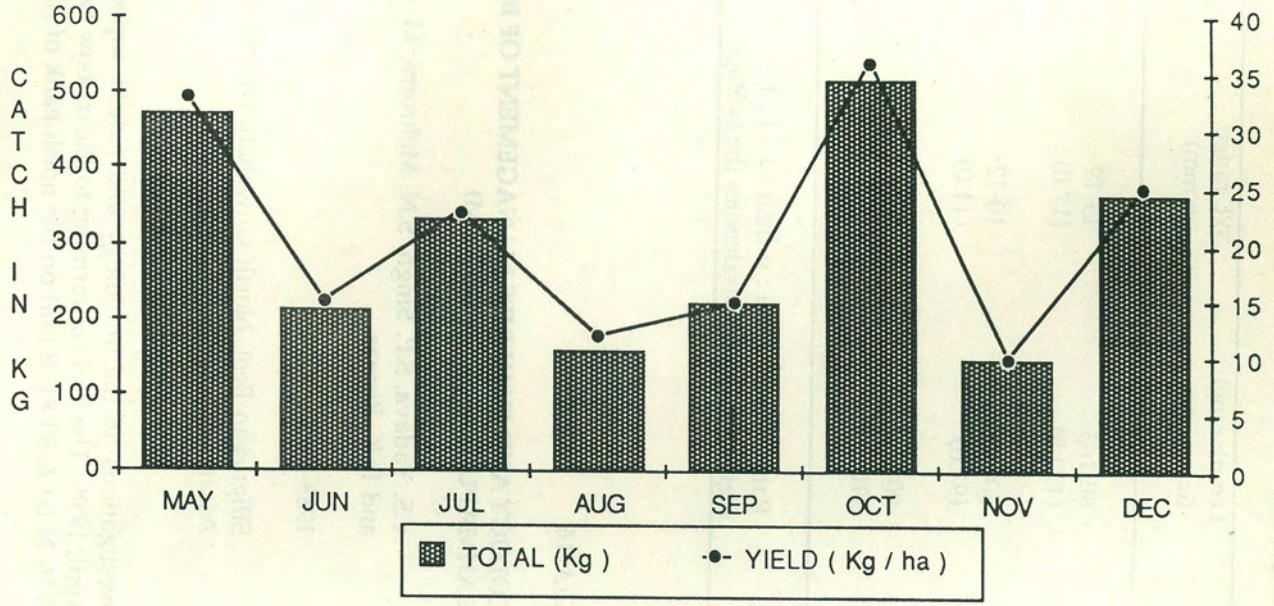
Personnel : Y.S. Yadava, S.P. Singh, S.N. Mehrotra, M. Choudhury and D.K. Biswas

Duration : 1988-1989

Location : Siligurijan Beel, North Guwahati, District Kamrup, Assam

Investigations on the limnology and fishery aspects of Siligurijan beel were initiated during April, 1988. The beel conforming to the ox-bow type is located *c.* 40 km from Guwahati city (26°26' N lat & 90°81' E lon) on the north bank of River Brahmaputra. A flood

FIG. 1 TOTAL AND PER HECTARE FISH LANDINGS FROM SILIGURIJAN BEEL



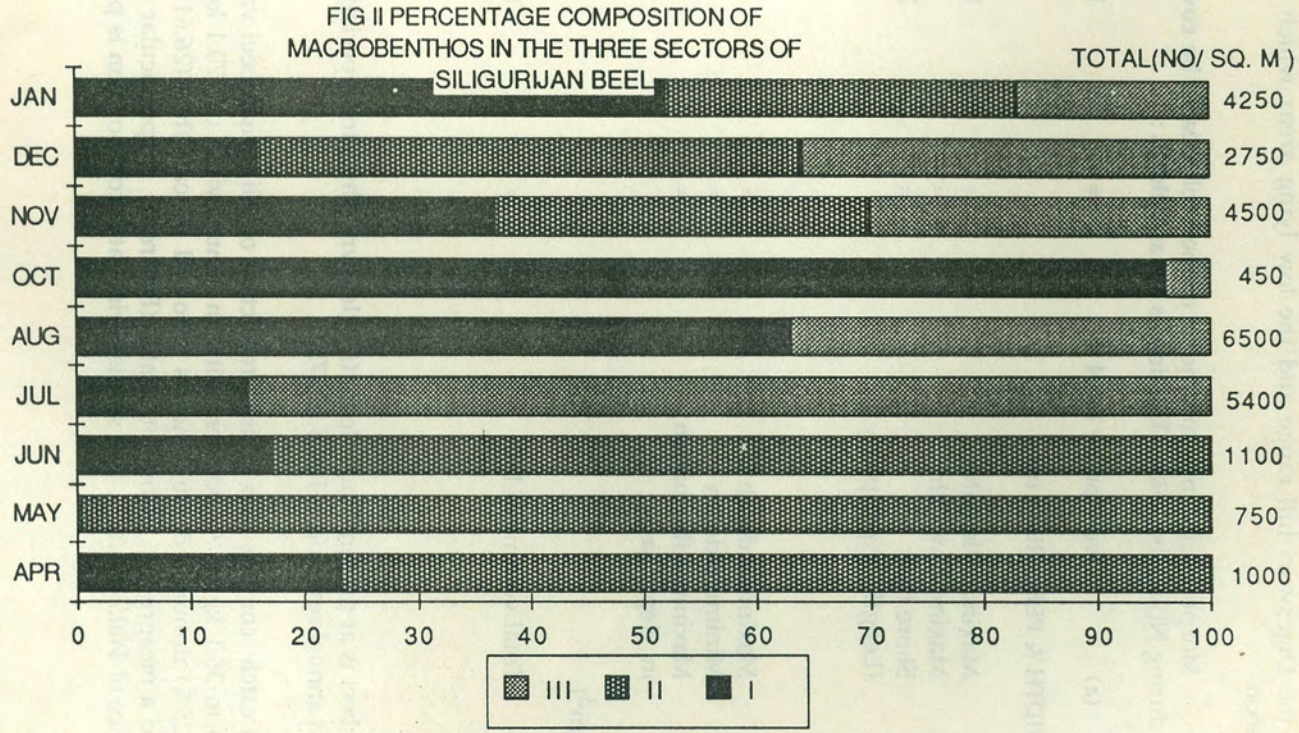


FIG II PERCENTAGE COMPOSITION OF
MACROBENTHOS IN THE THREE SECTORS OF
SILIGURIJAN BEEL
TOTAL(NO/ SQ. M)
JAN
DEC
NOV
OCT
AUG
JUL
JUN
MAY
APR
4250
2750
4500
450
6500
5400
1100
750
1000
0
10
20
30
40
50
60
70
80
90
100
III
II
I

protection embankment separates the beel from the flood-plains of the river. Although a sluice gate is constructed on the embankment, it seldom functions. The catchment area of the beel consists of the Digeswari hill range and the low lying areas which accumulate rain water during monsoon.

Morphometric measurements of the beel area to be covered under the project were made during November 1988. The details are as follows :

AREA (ha)	(a)	Live storage level	=	*c.*	14.38
LENGTH, WIDTH & PERIPHERY (m)					
	(a)	Maximum length	=	*c.*	1226.0
	(b)	Maximum width	=	*c.*	51.0
	(c)	Shore line (Length of periphery)	=	*c.*	2426.0
DEPTH (m)					
	(a)	Maximum depth	=	*c.*	4.72
	(b)	Minimum depth	=	*c.*	1.21
	(c)	Maximum fluctuation in depth (a-b)	=	*c.*	3.51
CAPACITY (m^3)					
	(a)	Total volume at LSL	=	*c.*	1,01,494

The beel is at present under lease (single ownership) for a period of three years (1.7.86 - 30.6.89) at an annual revenue of Rs.28,999.75.

Fish catch composition : Fish production of Siligurijan beel varied from 10.4 kg ha^{-1} (November) to 36.1 kg ha^{-1} (October) with an annual yield of 170.1 kg ha^{-1}. Miscellaneous species (46.25%) dominated the fisheries followed by catfishes (26.61%). Major and minor carps formed a meagre 13% of the total catch (Figure I). A spectacular feature of the beel was the dominance of *Wallago attu* . The species-wise catch composition is presented in Figure II.

The fish production of the beel received a major setback due to the outbreak of epizootic ulcerative syndrome disease (EUS). The disease was observed during the period September-November and almost all the species except *Wallago attu* were found to be affected.

Abiotic features of the beel : The physico-chemical characteristics of water of Siligurijan beel were evaluated to assess its present productive capacity. Primary production in the beel varied from 20.0 to 183.3 mg C m^{-3} hr^{-1} (GPP) and 0.0 to 111.11 mg C $m^{-3}hr^{-1}$ (NPP), while respiration ranged between 0.0 and 225.0 mg C m^{-3} hr^{-1}. The range and average values of physico-chemical parameters of the beel water are depicted in Table 1.

TABLE- 1. RANGE AND AVERAGE VALUES OF PHYSICO-CHEMICAL PARAMETERS OF WATER OF SILIGURIJAN BEEL (APRIL 1988-JANUARY 1989)

Sl.No.	Parameters	Range	Average
1	Air temperature (°C)	16.8-33.0	27.0
2	Water temperature (°C)	18.8-31.0	26.0
3	Depth (cm)	80.0-471.0	220.9
4	Transparency (cm)	25.0-122.1	54.3
5	pH	6.2-7.2	6.7
6	Free CO_2 (mg l^{-1})	0.0-62.0	13.5
7	Dissolved O_2 (mg l^{-1})	0.0-8.2	4.75
8	Hardness (mg l^{-1})	24.0-52.0	36.8
9	Alkalinity (mg l^{-1})	25.0-80.0	43.3
10	Calcium (mg l^{-1})	14.0-32.0	20.4
11	Magnesium (mg l^{-1})	10.0-23.0	16.4
12	Iron (mg l^{-1})	0.74-6.1	2.69
13	Chloride (mg l^{-1})	4.0	1.5
14	Silicate (mg l^{-1})	0.2-3.0	1.5
15	Nitrate nitrogen (mg l^{-1})	0.16-0.28	0.208
16	Ammonical nitrogen (mg l^{-1})	0.01-12.0	6.42
17	Total phosphate (mg l^{-1})	1.4-6.2	3.09
18	Ortho phosphate (mg l^{-1})	0.25-2.2	1.19
19	Total dissolved solids (mg l^{-1})	29.5-82.9	39.07
20	Dissolved organic matter (mg l^{-1})	27.2-62.4	38.6
21	Conductivity (μ mhos cm^{-1})	55.0-163.8	79.45

Biotic features of the beel : The beel has very less infestation of submerged vegetation but water hyacinth tends to accumulate with the onset of monsoon. The nutrient status of the beel in terms of plankton, macrobenthos and detritus was moderate to rich.

Plankton : The plankton density in the beel ranged from 33 u l^{-1} to 1733 u l^{-1}, with an average of 337 u l^{-1}. Phytoplankton (66.17%) dominated over zooplankton (33.83%). The trend was similar in all the three sectors of the beel where collections were made. The phytoplankton structure in the beel was in the order : Chlorophyceae (73.99%) > Bacillariophyceae (18.39%) > Myxophyceae (5.83%) and > Conjugatophyceae (1.79%) and zooplankton in the order : Copepoda (59.65%) > Rhizopoda (17.54%) > Rotifera (14.91%) and > Cladocera (7.89%).

The important genera constituting the phytoplankton were *Zygnema* sp. (43.39%), *Diatoma* sp. (8.33%), *Coelastrum* sp. (8.33%), *Protococcus* sp. (7.51%), *Microspora* sp. (5.33%), *Ulothrix* sp. (3.33%) and *Merismopedia* sp. (33.33%). Zooplankton were represented mainly by *Cyclops* (37.15%), Nauplius larvae (22.50%), *Brachionus* sp. (11.30%). *Actinosphaerium* sp. (6.45%) and *Euglypha* sp. (6.45%).

Macrobenthos : The macrobenthic density in the beel ranged from Nil (Sector II - October) to 4119 u m^{-2} (Sector I - August) with an overall average of 2994 u m^{-2} during the period of observation (Figure II). The benthic composition was in the order : Oligochaeta (68.95%) > Diptera (17.05%) > Gastropoda (8.25%) > Pelecypoda (5.03%) > Hirudinea (0.32%) > Water mites & Odonata (0.16%) > Porifera (0.08%).

The structure of the benthic community was composed of 18 taxa. Dominated by *Tubifex* sp. (68.46%), more than 85% of the organisms were represented by only 3 species as tabulated in Table 2.

TABLE - 2. THE STRUCTURE OF BENTHIC COMMUNITY IN SILIGURIJAN BEEL (THE SPECIES ARE RANKED BY NUMBER PER SQ M)

Rank	Species	No.	%
1	*Tubifex* sp.	18449	68.46
2	*Chironomus* larvae	3384	12.56
3	*Culicoides* sp.	1211	4.49
4	*Pisidium clarckeanum* sp	1040	3.86
5	*Gyraulus convexiusculus*	887	3.29
6	*Digoniostoma cerameopoma*	816	3.03
7	*Bellamya bengalensis*	457	1.70
8	*Lamellidens corrianus*	235	0.87
9	*Nais* sp.	130	0.48
10	Water mite	86	0.32
11	*Placobdella* sp.	43	0.16
12	*Hagenius* sp.	43	0.16
13	*Parreysia favidens*	43	0.16
14	*Corbicula striatella*	38	0.14
15	*Thiara melanoides*	22	0.08
16	*Indoplanorbis exustus*	22	0.08
17	Sponge	22	0.08
18	*Brotia costula*	19	0.07
	Total :	26947	

The benthic diversity, H (S) fluctuated between 1.1921 and 2.1874 revealing moderately polluted to unpolluted status of the beel.

Detritus : The detrital load (dry weight) ranged from 67.7 ± 21.3 g m^{-2} to 235.3 ± 222.8 g m^{-2} during the period of observation and reflected on the enormous amount of detrital energy lying in the beel basin. The poor representation of benthivores (11.08% of the total fish landings) is largely responsible for the under utilization of this important food niche. Management guidelines for the beel would stress upon the immediate addition of *C. mrigala, L. rohita, L. calbasu* and *L. gonius* fingerlings for utilization of the detrital energy. The seasonal abundance of detritus in the beel is tabulated below (Table 3).

TABLE - 3. SEASONAL INCIDENCE (DRY WEIGHT) OF DETRITUS LOAD ($g\ m^{-2}$) IN SILIGURIJAN BEEL (APRIL 1988 TO JANUARY 1989).

Sectors	Pre-monsoon	Monsoon	Post-monsoon	Average
I	216.4	417.5	104.7	235.3 ± 222.8
II	115.4	NR	191.8	140.8 ± 142.7
III	NR	81.5	59.9	67.7 ± 21.3

(NR = not recorded)

Cage culture : Twelve split bamboo mat cages of dimension 2 X 1 X 1 m have been constructed for cage culture trials in the beel. The experiment is to be initiated in the first week of March. Pen cultrure could not be undertaken due to the outbreak of EUS in the beel.

PROJECT BF/B/2

ECOLOGY AND FISHERIES MANAGEMENT OF ESTUARINE WETLANDS (BHERIES)

Personnel : Apurba Ghosh, Amitabha Ghosh, G.N. Chattopadhyay (upto January 1989), P.K. Chakraborti, K.R. Naskar, R.K. Das and N.N. Mazumder

Duration : 1986-1990

Location : Barrackpore

Investigations on the ecological variations of non-saline and saline sewage-fed wetlands were continued. Studies on the planktonic population of the freshwater wetlands showed dominance of *Brachionus* sp., *Keratella* sp., *Hexarthra* sp., *Asplanchna* sp., *Cyclops*

sp., nauplii of copepods, *Daphnia* sp., *Moina* sp., etc. among zooplankton and *Lyngbya* sp., *Closterium* sp., *Synedra* sp., *Merismopedia* sp., *Navicula* sp., *Pinnularia* sp., *Anacystis* sp., *Spirogyra* sp., and *Anabaena* sp. among phytoplankton in the non-saline sewage-fed wetlands of Salt Lake and Bantala. In an impoundment near Titagarh, *Cyclops* sp., followed by *Brachionus* sp., and *Moina* sp., were dominant among zooplankton and *Synedra* sp., *Closterium* sp. among phytoplankton. The numerical densities of plankters from various centres are given in Table 1. The average settled volume of plankton was 0.3 ml 50 l^{-1} of water in Salt Lake and Bantala while in Titagarh it was 0.4 ml 50 l^{-1}. In Minakhan and Malancha, saline wetlands mysid of prawn were found to dominate the zooplankton during June-August, followed by *Cyclops* sp. and *Diaptomus* sp. The principal phytoplanktonic forms in these wetlands were *Amphora* sp., *Closterium* sp., *Spirulina* sp., *Oscillatoria* sp., *Lyngbya* sp. and *Navicula* sp. In Malancha, the density ranged between 0.3 ml & 0.6 ml 50 l^{-1}, while in Minakhan, it was between 0.25 ml and 0.4 ml 50 l^{-1} (Table 1).

Among the benthic forms, odonate nymphs, chironomid larvae, *Lamellidens* sp., and *Indoplanorbis* sp. were found to be the principal zoobenthos, while *Spirogyra* sp. and *Merismopedia* sp. formed the principal phytobenthos in freshwater zone. In the saline zone (Minakhan-Malancha), *Gammarus* sp., teneid worms, *Enteromorpha* sp., *Oscillatoria* sp., and *Gyrosigma* sp. were the principal constituents of benthic community. The concentration of benthos at various centres is given in Table 2.

Excessive recruitment of tilapia in wetland resulted in low yield of harvestable size group of the species. Tilapia were primarily introduced for controlling algal growth. Previous experiments conducted under this project proved *Lates calcarifer* to be an effective agent for controlling the recruitment of *Oreochromis mossambicus*. To evaluate the effects of low density stocking of *Lates* on a mixed fish population, a sewage-fed impoundment (0.17 ha) was stocked with *Cyprinus carpio* @ 240 ha^{-1} where a stock of bigger tilapia (110 m 32 g^{-1}) along with small juveniles of the species (60 mm to 20 mm .017-.154 g^{-1}) were present. *Catla catla* were also introduced in the impoundment after stocking of *Lates* @ 50 ha^{-1}. Seven size groups of *Oreochromis mossambicus* from spawn to adult (257 mm 300 g^{-1}) were found to be existing in the population. *Catla* however, did not demonstrate any appreciable growth and the *Cyprinus* specimens in the range of 392-500 mm succeded in escaping predation. An on-farm investigation was also conducted in the Minakhan wetland using *Lates* as biocontrolling agent. A segment (0.02 ha) of the selected wetland was stocked with *Oreochromis mossambicus* and *Oreochromis niloticus* in the month of August 1988 @ 20,000 ha^{-1} and 200 ha^{-1} respectively. *Lates calcarifer* (Av. size 60 g) were stocked simultaneously. During final harvesting in the month of February, absence of small juveniles of *Oreochromis* in the catch suggested effective control of their recruitment by *Lates calcarifer*.

TABLE - 1. AVERAGE PLANKTON DENSITY (HUNDRED UNITS LITRE^{-1}) DURING 1988-89

Groups	Minakhan-Malancha	Salt Lake	Bantala	Hundipota	Titagarh
Filamentous algae	2.30	1.80	1.90	1.10	5.00
Diatoms	0.20	1.20	1.00	0.30	2.00
Other algae	0.40	3.30	2.00	0.50	10.20
Crustraceans	0.30	0.70	0.30	0.10	10.90
Rotifers	0.05	3.20	2.10	0.10	0.01
Other zooplankters	0.01	0.30	0.05	0.03	0.05
TOTAL :	**3.26**	**10.50**	**7.35**	**2.13**	**28.16**

TABLE - 2. AVERAGE BENTHOS DENSITY (THOUSAND UNITS M^{-2} DURING 1988-89

Groups	Minakhan-Malancha	Salt Lake	Bantala	Hundipota	Titagarh
Filamentous algae	43.30	1.90	6.30	4.60	8.80
Diatoms	3.70	1.90	1.00	0.30	1.70
Other algae	2.80	1.40	10.80	3.90	4.60
Crustaceans	14.40	4.00	0.30	0.03	0.40
Rotifers	1.00	0.80	0.20	0.03	0.20
Insect larvae	0.30	0.20	0.06	0.02	1.20
Molluscs	0.05	0.10	0.40	0.70	0.30
Miscellaneous	0.20	6.60	0.90	0.01	2.10
TOTAL :	65.75	16.90	19.96	9.59	19.30

Highly acidic soils have been identified in some of the estuarine wetlands of West Bengal. pH of these soils has been observed to be as low as 3.5 which declined further on oxidation indicating that these soils are acid sulphate. Occurrence of such soils restrict production of fish food organisms and also impair growth and physiological functions of animals due to low pH and unfavourable ionic composition of water. The soils exhibited comparatively higher values of organic C, Fe and Al. Availability of P was usually limited and transformation of this element was largely influenced by Ferric phosphat forms. Continuous submergence with lime improved the condition to some extent. However, the doses of lime are yet to be worked out based on the initial properties of the soils.

The marginal flora of the sewage-fed freshwater wetlands were studied. The growth and dominance of *Eichhornia* sp., *Alternanthera* sp., *Colocasia* sp., *Enhydra* sp. and *Chenopodium* sp. were recorded. Usually *Eichhornia crassipes* was kept as barricade to check soil erosion from the margins. These weeds also provided shade for the fish fauna of the shallow water bodies during summer.

The periodical survey of brackishwater mixed sewage-fed wetlands at Minakhan and Malancha area revealed the existence of mangrove plants like *Excoecaria agallocha, Sonneratia caseolaris, Acanthus ilicifolius* and *Clerodendrum inerme* and several grasses and sedges like, *Panicum* sp., *Sporobolus* sp., *Paspalum* sp., *Scirpus* sp., *Fimbrystylis* sp., and *Cyperus* sp. on the margins and bottom of the wetlands. These plants when alive encourage periphytic growth. On decay, they serve as manure for the soil and water.

The microbiological studies in respect of wetlands indicated that the productivity of these water bodies is a function of :

a) Concentration of intake of sewage effluent,

b) suspended organic particles,

c) texture of the bottom sediment,

d) dilution, and

e) salinity.

Calcutta market receives a large quantity of quality fish produced from these sewage-fed water bodies by adopting low input technology. This has been possible by the precipitation of most of the toxic metals like, mercury, lead, arsenic, copper, cadmium etc. as insoluble sulphides and release of inorganic nutrients inside the long open canal by the microbial decomposition of the waste materials coming along with the Calcutta sewage effluents.

Of the three zones, Bantala receiving medium to strong sewage is a freshwater zone and has been found to be the most productive from microbiological point of view. Beneficial bacteria (as shown in the table 3) were in optimum number and carry out the mineralization processes without creating any pollution. Minakhan and Malancha areas received still dilute sewage effluents and were again influenced by the saline tidal water. Consequently, Minakhan was having microbial activity lower than that of Bantala. Malancha area, though receiving still dilute sewage effluents, showed higher microbial activities (Table 3) because of the local sewage outlets, enriching the area.

Number of Actinomycetes (aerobic organisms) at the bottom, being comparable to that of bacteria, indicated that sufficient dissolved oxygen was also present at the soil water interface and, as such, bottom feeders were also expected to grow well in these water bodies.

TABLE - 3. MICROBIAL ACTIVITIES IN DIFFERENT SEWAGE -FED ESTUARINE WETLANDS

		Water	Sediment
Bantala			
1.	Heterotrophic bacteria	4.8×10^3 ml^{-1}	3.8×10^6 g^{-1}
2.	Phosphate solubilizing bacteria	2.8×10^2 ml^{-1}	2.9×10^6 g^{-1}
3.	Nitrogen fixing bacteria	4.5×10 ml^{-1}	1.8×10^6 g^{-1}
4.	Actinomycetes	2.2×10^2 ml^{-1}	3.5×10^6 g^{-1}
Minakhan			
1.	Heterotrophic bacteria	4.1×10^2 ml^{-1}	2.1×10^5 g-1
2.	Phosphate solubilizing bacteria	3.9×10^2 ml^{-1}	3.4×10^5 g-1
3.	Nitrogen fixing bacteria	4.0×10 ml^{-1}	7.0×10^4 g-1
4.	Actinomycetes	1.8×10^2 ml^{-1}	3.1×10^5 g-1
Malancha			
1.	Heterotrophic bacteria	2.72×10^3 ml^{-1}	4.4×10^5 g-1
2.	Phosphate solubilizing bacteria	3.7×10^2 ml^{-1}	2.9×10^5 g-1
3.	Nitrogen fixing bacteria	1.4×10^3 ml^{-1}	2.0×10^5 g-1
4.	Actinomycetes	2.0×10^2 ml^{-1}	6.5×10^5 g-1

PROJECT BF/B/3

ECOLOGY AND PRODUCTION BIOLOGY OF HOOGHLY-MATLAH AND KULTI ESTUARINE SYSTEMS

Personnel : B.N. Saigal, Apurba Ghosh, R.N. Pal, B.B. Ghosh, G.N. Saha, Babu Lal, A.K. Ghosh, M.K. Mukhopadhyay, H.C. Joshi,A.K. Ghosh, Amitabha Ghosh, K.R. Naskar, R.K. Banerjee, M.M. Bagchi, M.K. Das, R.K. Das, P.M. Mitra, G.N. Chattopadhyay, P.K. Chakraborty, H.C. Karmakar, D.K. De, S.N. Dutta, S.C. Thakurta, G.C. Laha, D. Nath, S.N. Singh, S.K. Sarkar, R.N. Dey, S.N. Sar, A.R. Paul, A.K. Roy, N.N. Majumdar, N.C. Mondal, S.P. Ghosh, K.S. Banerjee, A.K. Banerjee, Pintu Biswas, T. Chatterjee, S.K. Chatterjee, Keya Saha, S.K. Chakraborty, R.M. Roy, T.P. Ghosh, B.B. Das, Saradindu Chakraborty, H.K. Routh, K.K. Das, Debasis Sanfui, Suvra Das, L.K. Parbat

Duration : 1983-90

Location : Barrackpore, Canning, Uluberia, Diamond Harbour, Digha and Frazerganj/Namkhana.

Sub-Project - I : Assessment of fishery resources, biological investigations and stock recruitment studies and monitoring of ecological parameters of the estuarine systems

SAMPLE SURVEY FOR ESTIMATION OF CATCH AND EFFORT

Total fish landings

Estimated total fish yield from the Hooghly-Matlah estuarine system amounted to 31,146.6 t during the period November, 1987 to October, 1988 showing an increase of 11,348.7 t (57%) compared to the corresponding period of the previous year. Estimated total landings for the period November, 1988 to January, 1989 amounted to 36,684.3 t compared to 25,900.4 t during November, 1987 to January, 1988. The major share of the catch (93%) was from the winter migratory bagnet fishery during November 1988 to January 1989 with an average CPUE of 157.43 kg. Compared to 1985-86, the increase was 15%. Yield per ha increased from 30 kg to 34.6 kg (Table 1).

Zone-wise and month-wise catch structure

The lower estuarine zone alone accounted for about 95% of the total fish landings with 6.2% and 3.1% standard errors, at the assembly centres and winter bagnet fish catch

TABLE - 1. GROUP-WISE YIELD (kg ha^{-1}) IN HOOGHLY-MATLAH ESTUARINE SYSTEM

Species/Species-group	Average of 1983-86	Average of 1987-88
Tenualosa ilisha	2.23	1.31
Other clupieds	3.20	7.07
Catfishes	0.69	1.13
Polynemids	0.28	0.42
Sciaenids	3.85	4.58
Mullets	0.03	0.02
Ribbon fishes	3.21	2.78
Bombay duck	4.95	5.65
Prawns	2.69	1.99
Miscellaneous	8.90	9.66
Total	**30.03**	**34.61**

respectively. Monthly catch distribution of the lower estuarine zone and other stretches of the Hooghly estuary is depicted in Fig. 1.

Species composition

In order of abundance, *Harpodon nehereus, Setipinna* spp., *Pama pama, Trichiurus* spp; *Coilia* spp., *Tenualosa ilisha* and various prawn species constituted the dominant fishery of the estuary accounting for nearly 19,509.2 t (62.5%) of the total catch. Fish and prawn species which formed the bulk catches in 1987-88 and 1986-87 are presented in Table 2).

Hilsa fishery

Without taking into account the winter migratory bagnet fishery, *T. ilisha* formed the mainstay of the estuarine fishery, contributing 1,177 t being 16% of the total catch compared to 1935 t during 1986-87 exhibiting thereby a major decline of 758 t (40%).The mean length of hilsa was 38.0 cm with a length range of 22.4 to 51.6 cm representing II to V year age groups during monsoon period.

Zonewise total hilsa catch, effort and CPUE by different gears in 1987-88 and 1986-87 are presented in Table 3.

Winter migratory bagnet fishery

Total estimated winter migratory bagnet fish catch during mid-October 1987 to early February, 1988 amounted to 23,775.6 t forming about 76% of the total estuarine catch with an average CPUE of 83.37 kg during last winter, an unusually lean year of winter fishery. The dominant species contributing to the fishery in order of abundance were : *H. nehereus, Setipinna* sp., *P. pama, Trichiurus* spp., *Coilia* spp. and prawns. These species accounted for 65% of the total winter bagnet catch.

Gearwise composition of catch

Bagnets and drift gill nets constituted the most dominant gears in the entire estuary, accounting for 90% of the total catch (Bagnets 82%, gill 8%). Gearwise composition of catch for different zones is presented in Table 4 .

Bagnet fishery

Zonewise bagnet catches, effort and CPUE other than that of winter migratory bagnet fishery, are depicted in Fig. II.

While tidal amplitude was found to be one of the significant factors directly contributing to fish catch by multispecies gears, it did not have any impact on fish catch by selective gears. Correlation coefficients between CPUE and tidal amplitude for different gears are presented below :

Gear	Correlation coefficients	Significance
Bag net	0.6908	$P < 0.01$
Cast net	0.5707	$P < 0.01$
Set barrier net	0.4135	$P < 0.01$
Purse net	-0.0718	$P < 0.05$
Trawl	0.4007	$P < 0.01$
Drift-gill net	-0.0240	$P < 0.05$
Seine	0.6120	$P < 0.01$
Hook and line	0.6127	$P < 0.01$

The sizes of the nets in case of some multispecies gears have significant positive correlation with fish catch. Multiple correlation coefficient of catch per unit effort (CPUE) on tidal amplitude and size of the net was estimated at 0.7246 in case of bagnet explaining 52/5% of variability in CPUE. The multiple regression equation of CPUE on tidal amplitude and size of the net can be expressed as :

$$X_1 = -8.5056 + 0.9779 X_2 + 0.9123 X_3$$

Where X_1 is the CPUE in kg, X_2 is the number (in hundred) of meshes at the periphery of the mouth of the net which varies between 400 to 1200 and X_3 is the tidal amplitude in metre. The regression coefficients were also tested by F-test and found to be highly significant.

Analysis of variance of fish yield from different stretches of the estuary over two periods *viz.*, pre-Farakka and recent years (1984-85 to 1987-88) was taken up after introducing log transformation. ANOVA revealed significant differences between stretches over the two periods.

Hydrobiological investigations

Freshwater zone in the Hooghly estuary was recorded to be extended up to Uluberia (max. 0.041 ppt salinity). A gradual increase in salinity was reflected thereafter at Nurpur (max. 1.585 ppt). Highest salinity values were recorded at Digha (max. 26.407 ppt).

The pH values ranged from 7.4-8.6, DO from 5.1-8.0 ppm, turbidity from 85-100 units, total alkalinity from 44-167 ppm, salinity from 0.027-26.407 ppt, sp. conductivity from 163-23215 micromhos/cm, hardness from 66-4981 ppm, nitrate from Tr. - 0.2 ppm,

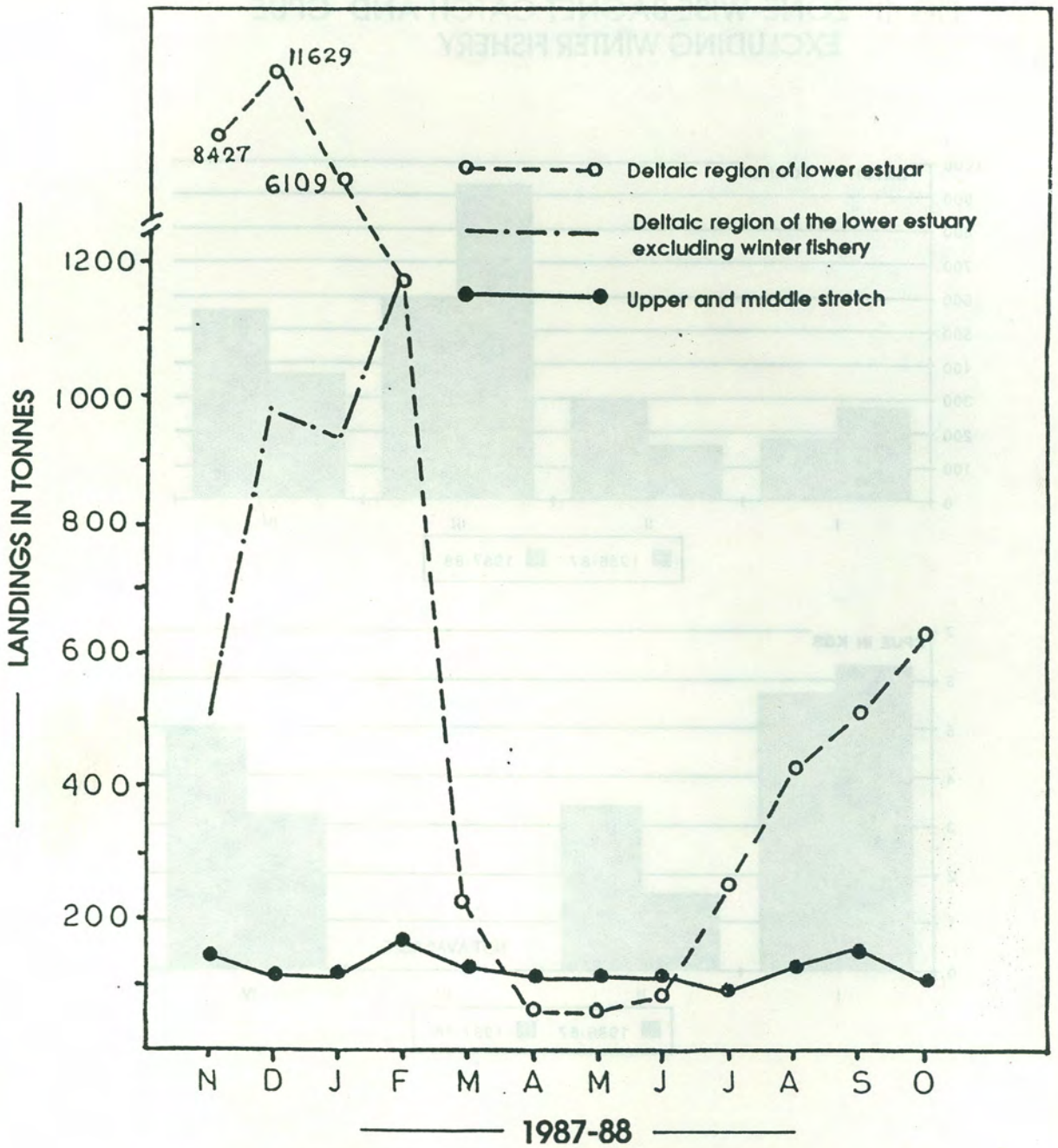
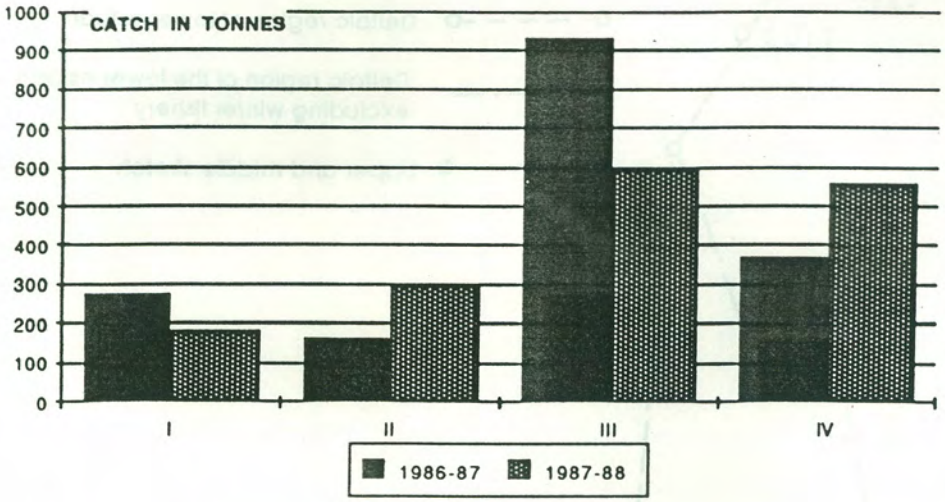


FIG. I MONTH-WISE CATCH IN LOWER, UPPER AND MIDDLE STRETCHES OF THE ESTUARY

FIG II ZONE-WISE BAGNET CATCH AND CPUE EXCLUDING WINTER FISHERY



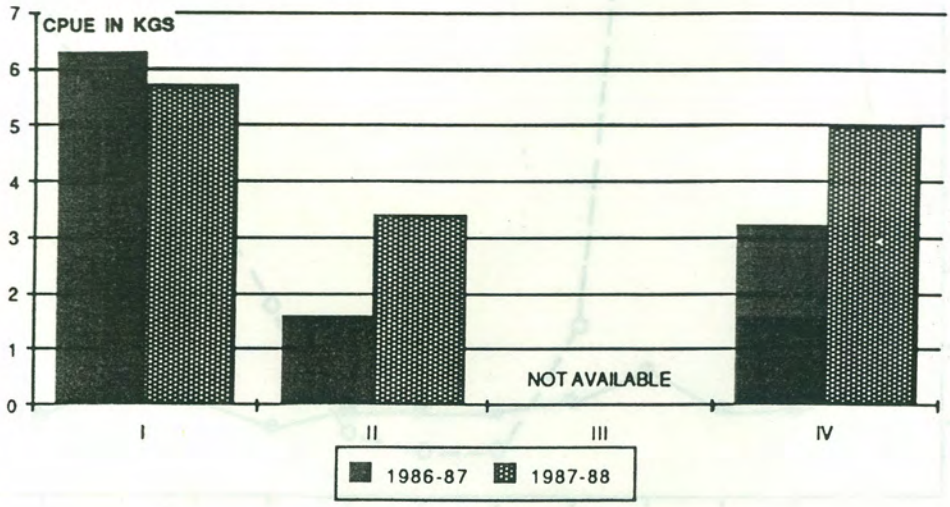


TABLE - 2. CONTRIBUTION OF DOMINANT FISH SPECIES AND PRAWNS (in t) TO THE TOTAL ESTUARINE FISH CATCH

Species	Contribution to total catch		% in the total catch		Contribution to total catch excluding winter fishery		% of col 6	% of col. 7
	Nov.'87-Oct.88	Nov.'86-Oct.87	Nov.'87-Oct.88	Nov.'86-Oct.87	Nov.'87-Oct.88	Nov.'86-Oct.87		
1	2	3	4	5	6	7	8	9
Tenualosa ilisha	1177.0	1935.3	3.8	9.8	1182.6	1934.9	16.0	25.4
Pama pama	3514.8	1090.8	11.3	5.5	325.1	805.1	4.4	4.0
Setipinna spp.	3852.5	1196.5	12.4	6.0	385.7	356.1	5.2	2.2
Trichiurus spp.	2502.3	1451.3	8.0	7.3	91.6	139.1	1.2	0.7
Harpodon nehereus	5084.1	2596.5	16.3	13.1	436.4	316.7	5.9	3.0
Tachysurus jella	758.0	366.6	2.4	1.9	332.3	345.2	4.5	5.4
Stromateus inereus	682.2	351.8	2.2	1.8	151.2	225.1	2.0	2.7
Polynemus paradiseus	179.4	141.4	0.6	0.7	97.8	134.9	1.3	1.1
Coilia spp.	1591.5	536.7	5.1	2.7	684.5	349.5	9.3	1.0
Ilisha elongata	838.8	288.3	2.7	1.5	98.4	176.8	1.3	1.3
Sciaena biauritus	604.4	92.6	1.9	0.5	64.5	20.4	0.9	0.4
Polynemus indicus	174.9	147.2	0.6	0.7	161.6	147.2	2.2	0.3
Prawns	1787.0	2563.5	5.7	12.9	1034.2	1421.9	14.0	7.6
Others	8399.7	7039.4	27.0	35.6	2325.2	5299.3	31.6	44.9
Total	31146.6	19797.9	100.0	100.0	7371.1	11672.2	99.8	100.0

TABLE - 3. ZONEWISE TOTAL HILSA CATCH, EFFORT, CPUE BY DIFFERENT GEARS IN 1987-88 and 1986-87

Zone	Gear	Catch (t)		Effort (net tides)		CPUE (kg)	
		1987-88 (Nov.-Oct.)	1986-87 (Nov.-Oct.)	1987-88 (Nov.-Oct.)	1986-87 (Nov.-Oct.)	1987-88 (Nov.-Oct.)	1986-87 (Nov.-Oct.)
I	Purse	31.9	32.6	54,745	67,794	0.58	0.48
	Drift	87.1	206.2	2,22,504	3,21,432	0.39	0.64
	Set-gill	41.4	42.0	32,749	26,438	1.26	1.59
	*Bag	10.0	16.9		-		-
	*Others	0.9	0.4		-		-
	Total	**171.3**	**298.1**				
II	Drift	146.1	510.6	1,61,622	3,20,277	0.90	1.59
	*Bag	2.6	3.9		-		-
	*Others	0.5	0.5				
	Total	**149.2**	**515.0**				
III	Drift	738.2	641.2	-	-	N.A.	N.A.
	Others	10.2	315.7	-	-		
	Total	**748.4**	**956.9**				
IV	Drift	76.5	143.0	91,802	1,43,358	0.83	1.00
	*Bag	29.8	21.9		-		
	*Others	1.8	0.3		-		
	Total	**108.1**	**165.2**				
	Total	**1177.0**	**1935.2**				

* Juveniles of Hilsa

TABLE- 4 . GEARWISE ZONAL CATCH (in t) DURING NOVEM BER 87 TO OCTOBER 88

Gear	Zone I	Zone II	Zone III		Zone IV	Total		% in the total catch	
			Including winter fishery	Excluding winter fishery		Including winter ishery	Excluding winter fishery	Including winter fishery	Excluding winter fishery
Drift-gill	119.0	158.1	2205.6	2205.6	76.5	2559.2	2559.2	8.2	34.7
Bag	276.5	160.7	24709.6	934.1	368.5	25515.3	1739.8	81.9	23.6
Trawl	62.6	-	-	-	-	62.6	62.6	0.2	0.9
Small Seine	3.6	-	129.5	129.5	3.1	136.2	136.2	0.4	1.9
Large Seine	-	-	2257.4	2257.4	-	2257.4	2257.4	7.2	30.6
Cast	28.9	-	-	-	-	28.9	28.9	0.1	0.4
Purse	31.9	-	-	-	-	31.9	31.9	0.1	0.4
Set-gill	51.4	-	-	-	-	51.4	51.4	0.2	0.7
Set-Barrier	55.1	2.8	97.6	97.6	22.4	177.9	177.9	0.6	2.4
Lift	50.9	0.6	-	-	-	51.5	51.5	0.2	0.7
Hook & Line	0.5	3.3	20.6	20.6	0.1	24.5	24.5	0.1	0.3
Trap	47.5	-	-	-	-	47.5	47.5	0.2	0.6
Unclassified & Unknown	-	-	202.3	202.3	-	202.3	202.3	0.6	2.8
Total	**727.9**	**325.5**	**29622.6**	**5847.1**	**470.6**	**31146.6**	**7371.1**	**100.0**	**100.0**

phosphate from traces-0.4 ppm and silicate from 4-29 ppm in the Hooghly-Matlah-Rupnarayan estuarine ecosystems and coastal areas.

Plankton concentrations and ^{14}C assimilation rates indicated maximum values in coastal region of Bay of Bengal and thereafter with gradual declineing trend in the Hooghly estuarine stretches.

Rupnarayan had higher densities of bottom dwellers like polychaete worms (*Nereis, Neanthes* - 18 to 243 nos. m^{-2}), prawn post larvae (*M. rosenbergii, P. rudis, P. mirabilis, P. scabiculus* etc. 72 to 1008 no. m^{-2}) and harpecticoid copepods while in the main estuary the tide borne macrocrustaceans viz. : Mysids, *Gammarus* sp., *Asellus* sp. and *Acetes* sp. formed the principal items of the food chain.

Biology of *Polynemus paradiseus*

The size at first maturity in case of *P. paradiseus* has been observed to be 140 mm/10.3 g. The fecundity range was 2,475-42,500 (TL 140-198 mm, wt 10.3-43.0 g). The breedidng season was September.

Racial studies of *Hilsa ilisha*

Electrophoretic studies of blood serum have shown distinct differences in distribution pattern and densities of the protein bands in *Tenualosa ilisha* from Bhagirathi - Hooghly system and those from Ganga-Padma link down below the Farakka barrage.

Sub-Project - II : **Studies on the impact of industrial, agricultural and metropolitan wastes on estuarine environment in West Bengal.**

Pollution impact assessment was conducted in the Hooghly estuary around the outfall of soda process and pulp and paper mill at Tribeni, and the Titagarh Thermal Power Station.

Pulp manufacturing effluents indicated higher turbidity, sp. conductivity, pH (8-9), alkalinity and BOD and low DO (2.6-3.0 mg l^{-1}) compared to the combined wastes drained from paper machine and bleaching units. The latter effluent was especially characterised by presence of free chlorine which in association with increase in chloride, hardness and sp. conductivity and reduction in water pH and poor C/N ratio (3.7-4.3) of bottom sediment, showed marked pollution effect leading to occurrence of mortality of some estuarine fishes (*P. sophore, E. danricus, R. rita, M. vittatus* and *G. affinis)* near the outfall of soda process pulp and paper mill at Tribeni. Net primary production (28.1 mg C m^{-3} hr^{-1}), as assessed by dark and light bottle technique, was low.

Microbial population study in respect of heterotrophic bacteria, phosphate solubilising bacteria and aerobic nitrogen fixing bacteria involved in the self purification process and enrichment of nutrients in water indicated complete absence of these within 50 sq.m. downstream of the effluent discharge point. Although organic pollution was noted in the marginal stretch upto 1.5-2.0 km downstream, as indicated by BOD (6.9-9.1 mg l^{-1}), chlorine toxicity was found to be neutralised within 100 m downstream due to continuous flow of water from upstream during low tide (Table 5).

The hot water discharged from Titagarh Thermal Power Station, caused increase in ambient temperature (4.7-5.1°C), BOD and turbidity and reduction in DO (0.7 mg l^{-1}) and pH. However, the water temperature upto 35.7°C and other physico-chemical conditions were not found to be harmful to the above-mentioned groups of bacteria in water and sediment around the discharge point. Further, the temperature was found to favour the activities of phosphate solubilizing bacteria.

Monitoring of heavy metals *viz.*, Zn, Cu, Cr, Cd, Pb and Hg in different tissues and organs of the fish *Rita rita* was initiated at two locations in the industrial belt of the Hooghly. Unfavourable haematological conditions with respect to RBC, Hb and HTC were also recorded in the fish.

Pollution study in the Kulti estuary

Water and bottom sediment quality of the Kulti estuary receiving Calcutta metropolitan wastes at Ghusighata were monitored at five stations namely Kharibari, Ghusighata, Minakhan, Malancha and Bermazore. It revealed both organic and metal pollution in the entire stretch as evident from high BOD (38-90 mg l^{-1}) and COD (62-210 mg l^{-1}) and presence of metals like Cu, Zn and Cr both in water and sediment, higher concentration being recorded in sediments (max. Cu = 33.6 ug g^{-1}, Zn = 140 ug g^{-1} and Cr = ug g^{-1}). Beyond Kharibari in the north and Bermazore in the south, percent saturation of DO was always found to be 70 indicating recovery zone. Ghusighata, a point close to the outfall of city sewage, bears the lowest DO level (1.2-2.2 mg l^{-1}) and highest BOD (80-90 mg l^{-1}), COD (180-210 mg l^{-1}) and heavy metals (Zn, Cu and Cr). High phosphate noted in the water (0.10-0.21 mg l^{-1}) and bottom sediments (4.8-12.,0 mg l^{-1} as P_2O_5) was attributable to high concentration of synthetic detergents (max. 20 mg l^{-1} as MBAS) noted earlier.

The bottom sediment in the entire stretch being alkaline in reaction (pH 7.4-7.8), shows poor productivity which was reflected by low level of benthic population (6-10 nos. per sq.m.) mainly dominated by polychaetes and gastropod shells. The dominant plankton species encountered were *Brachionus, Heterophytes, Spirulina* and *Oscillatoria,* which were rather pollution resistant. The stretch was practically, devoid of any commercial fishery, the dominant fishes being *Aplochelius, Gobiids* and *Acetes.*

A device has been designed to entrap heavy metals from wastes by use of some ion exchangers.

TABLE - 5. PHYSICO-CHEMICAL CONDITIONS AND BACTERIAL LOADS OF WATER OF SEWAGE-FED BHERIES AT SALT LAKE

Months	Site	pH	Trans-parency	D.O. (ppm)	CO_2 (ppm)	Bicarbonate (ppm)	Water soluble Nitrogen (ppm)	Phosphate phosphorus (ppm)	Bacterial load (nos. ml^{-1})
August 1988	Goltala	9.2	23.3	9.2	3.0	66.0	5.6	0.25	7.5×10^2
November	Goltala	7.4	12.0	-	32.0	176.0	2.5	0.26	1.5×10^3
1988	Nalban	7.6	20.0	-	30.0	264.0	1.2	0.1	2.3×10^2
January	Goltala	7.3	20.5	12.6	18.0	213.0	0.56	0.3	-
1989	Nalban	7.4	24.0	9.5	16.0	234.0	0.26	0.25	-

Sub-Project - III : **Investigations on diseases of fishes encountered from estuarine, lacustrine and 'bheri' waters.**

Intensive investigations on the EUDS were made from various angles, viz., (a) identification of pathogens causing the disease, (b) environmental conditions acting as predisposing factors of the disease, (c) histopathological manifestations, haematological considerations and therapeutics and (d) development of managerial practices for controlling the horizontal transmission of the disease. Bacterial flora associated with the disease comprised : (i) *Micrococcus* sp., (ii) *Staphylococcus epidemidis*, (iii) *Aeromonas hydrophila*, (iv) *Pseudomonas flurescens*, (v) *Escherichia coli* and (vi) *Bacillus* sp. (aerobic and spore bearer) (Table 6).

However, repeated occurrence of *Micrococcus* sp. from the haemopoietic tissues of affected fishes and in the ambient environment (both soil and water) suggested that the disease might be bacterial in origin. Controlling the disease by bactericidal antibiotic drug also indicated the same. Live bacteria injected in dermis of apparently healthy fishes could also produce the disease. However, the experiment is still in progress as the exotoxin of the bacteria has been recently extracted and its haemolytic activity is also being studied.

Two sewage-fed bheries, managed by State Fisheries Development Corporation, Calcutta, were selected for studies on diseases of fishes cultured in that. Infestation of *Argulus* sp. was encountered in one of the bheries (Goltala) whereas myxosporidean infestation was recorded in the other (Nalban) during winter.

Sub-Project - IV : **Studies on the productivity of estuaries and connected impoundments using Radio-Isotopes, Carbon-14**

The higher values of primary productivity and energy fixation at the coastal sampling stations are attributable to the high organic depositions of the mangrove vegetations, shallower depth and effective solar penetration. In the entire estuarine stretch, the average value of ^{14}C assimilation was estimated to be 0.7825 g $Cm^{-2}day^{-1}$. The mean values of ^{14}C assimilation and energy fixation for the whole estuary were about 2.3×10^6 t carbon and 2.18×10^8 t of calories energy respectively. Based on these values the estimated fish yield potential from the Hooghly-Matlah estuarine system was 5.5×10^4 tonnes which is nearly 2.5 to 3 times more than the total estuarine landings of the country.

TABLE - 6. BACTERIAL FLORA ISOLATED FROM ULCERATIVE DISEASED FISHERIES

Sl. No.	Host	Organ of isolation	Species identified
1	*Catla catla*	Surface (Leison)	*Micrococcus* sp.
2	" "	Kidney	*Bacillus* (aerobic spore bearer)
3	" "	Liver	*Micrococcus* sp.
4	" "	Kidney	*Micrococcus* sp.
5	" "	Kidney	*Pseudomonas fluorescence*
6	*Labeo rohita*	Surface (Leison)	Gram (-) rod
7	" "	Kidney	*Staphylococcus epidermidis*
8	" "	Liver	*Bacillus* (spore bearer)
9	*Puntius stigma*	Leison	*Escherichia coli*
10	*Mystus vittatus*	Leison	*Bacillus* (spore bearer)
11	Water affected area	-	*Bacillus* (spore bearer)
12	*Channa punctatus*	Leison	*Bacillus* (spore bearer)
13	*Channa* sp.	Serum	*Micrococcus*
14	*Catla*	Leison	*Micrococcus*
15	"	Liver	*Micrococcus*
16	"	Kidney	*Micrococcus*
17	"	Heart	*Micrococcus*

PROJECT BF/B/8

ECOLOGICAL STUDIES ON TROPICAL MANGROVE VEGETATION ON WESTERN FRINGE AREA OF THE SUNDERBANS

Personnel : Apurba Ghosh, P.K. Chakraborti, K.R. Naskar, G.N. Chattopadhyay (upto January 1989), R.K. Das, A. Hajra, N.N. Mazumder.

Duration : 1986-1990

Location : Gosaba-Sajinakhali-Malancha-Kakdwip-Bakkhali

Examination of epiphytes and periphytes from mangrove roots revealed the existence of *Bartrychium* sp., *Caloglobossa* sp., *Canella* sp., *Murrayella* sp., *Chaetomorpha* sp., *Gleocapsa* sp., *Polysiphonia* sp. and *Enteromorpha* sp.

Plankton densities at Kakdwip, Bakkhali, Malancha, Gosaba, Durgaduania, Sajinakhali, and Sudhannyakhali were 0.6, 0.5, 1.1, 2.6, 1.5, 1.6 and 1.56 thousand units litre^{-1} (Table 1) while fluctuation of zooplankton ranged between 3 to 33%. The densities slightly declined from the previous years at Kakdwip, Malancha, and Gosaba and increased at Durgaduania.

Higher concentration of non-filamentous algae was noticed in the areas with freshwater influence. Impact of sewage effluents was noticeable in the production of algae in the Malancha area. High saline areas, especially the core areas, had higher diatom population. In addition to diatoms core areas were rich in *Chlorella* sp. Abundance of crustacean eggs and nauplii was maximum in Gosaba plankton.

Benthos densities were the maximum (76 thousand u m^{-2}) at Malancha. Details are given in Table 2.

Benthos from semi-core and core areas were devoid of rotifers. High concentration of diatoms at Durgaduania was mainly due to *Amphora* sp., but at Sajinakhali it was due to *Nitzschia* sp. and *Gyrosigma* sp. mainly. Polychaetes increased at Durgaduania during pre-monsoon and at Gosaba during monsoon. This was synchronised with the fall of nauplii and non-filamentous algae other than diatoms at Durgaduania and the decline of *Closterium* sp. at Gosaba.

Studies on the associated fauna indicated higher availability of fish fauna at Malancha, shrimps other than *Acetes* sp. in the semi-core and core areas, and of *Acetes* sp. at Gosaba and Sudhannyakhali (Table 3). Concentration of molluscs was more in high

TABLE - 1. PLANKTON (u l^{-1}) FOR THE FOUR QUARTERS OF THE YEAR 1988-89

Station	Filamentous algae	Diatoms	Other algae	Crusta-ecans	Rotifers	Other Zoo-plankton	Total
Kakdwip	266.5	29.9	182.3	116.1	15.9	5.3	616.0
	302.9	39.4	193.9	66.6	12.4	2.7	617.9
	215.7	24.6	133.1	193.1	26.5	8.7	601.9
	243.2	18.8	160.3	168.7	24.0	11.3	626.3
Bakkhali	303.3	20.9	61.8	80.8	16.5	5.3	488.6
	352.8	25.2	70.0	42.0	8.3	2.7	501.0
	261.2	11.5	48.8	137.0	29.2	9.6	497.3
	288.1	14.2	53.0	122.1	23.5	7.9	508.8
Malancha	430.7	53.6	359.2	273.3	4.7	12.4	1133.9
	607.3	27.4	342.6	327.3	1.2	19.8	1325.6
	233.6	43.4	889.4	201.4	2.4	15.1	1385.3
	362.2	277.5	393.7	444.7	101.7	16.8	1596.6
Gosaba	395.1	1108.5	82.6	987.0	83.0	-	2656.2
	415.3	1248.4	80.0	868.4	121.1	-	2733.2
	405.7	1362.2	104.7	563.1	128.5	-	2564.6
	386.5	1110.2	94.3	892.9	34.5	-	2518.5
Durgaduani	341.9	324.0	301.1	419.6	51.2	-	1437.8
	435.1	358.5	398.9	238.6	0.2	-	1431.3
	519.2	345.0	475.4	236.0	64.5	-	1640.1
	849.7	355.0	130.6	313.2	53.5	-	1701.8
Sajnakhali	506.9	447.6	69.5	383.5	118.8	-	1526.3
	615.8	509.3	92.5	351.3	122.8	-	1691.7
	509.4	431.0	65.6	377.8	22.2	-	1506.2
	719.4	412.5	28.9	383.8	109.1	-	1652.7
Audhannya-khali	485.0	443.5	54.4	465.6	57.0	-	1505.5
	627.0	533.4	74.9	451.8	53.7	-	1740.8
	630.6	456.8	65.2	242.1	122.6	-	1517.3
	537.4	562.4	63.8	262.4	112.7	-	1540.7

TABLE - 2. BENTHOS (u m^{-2}) FOR THE FOUR QUARTERS OF THE YEAR 1988-89

Station	Filamentous algae	Diatoms	Other algae	Crustaceans	Rotifers	Molluscs	Other zoo-benthos	Total
Malancha	45349	2550	428	1856	290	104	11685	62262
	71387	3335	308	819	48	64	639	76600
	72390	2716	4578	1023	717	33	176	81633
	58980	2647	2503	1735	804	64	5737	72506
Bakkhali	377	25	70	96	13	7	6	594
	430	33	81	49	6	3	4	606
	313	21	63	171	22	12	12	614
	337	22	62	147	78	11	8	605
Kakdwip	40	6	4	11	1	1	1	64
	43	6	5	8	1	1	-	64
	32	3	2	19	2	1	1	60
	36	3	1	15	2	1	1	59
Gosaba	129	705	7	69	2	3	44	959
	123	678	10	156	6	5	148	1126
	103	679	106	172	3	8	30	1101
	212	577	125	159	2	8	38	1121
Durgaduania	2857	1195	638	518	-	151	215	5574
	4412	872	44	23	-	152	31	5534
	2861	1059	772	356	-	287	92	5427
	2729	1209	794	534	-	209	71	5546
Sajinakhali	967	2384	237	403	-	123	9	4123
	969	2380	236	405	-	124	8	4122
	1045	2656	336	149	-	29	11	4226
	1089	2526	218	236	-	46	31	4146
Sudhannya-khali	159	326	166	171	-	14	80	916
	343	275	32	42	-	1	131	824
	212	452	77	111	-	8	56	916
	124	510	89	95	-	53	59	930

TABLE - 3. ABUNDANCE OF ASSOCIATED FAUNA (no. per man-hour) FOR FOUR QUARTERS OF THE YEAR 1988-89

Groups	Kakdwip	Bakkhali	Malancha	Gosaba	Durgaduania	Sajinakhali	Sudhannyakhali
Molluscs	3	5	142	14	80	64	74
	3	3	98	34	52	62	78
	4	11	58	66	100	132	168
	2	3	94	56	72	128	164
Fishes	5	16	294	20	32	36	36
	5	3	212	198	16	38	70
	10	19	190	106	38	54	256
	13	11	308	126	60	58	596
Shrimps	10	18	106	140	512	284	204
(excluding	5	28	70	114	126	234	200
Acetes)	5	26	100	128	470	224	194
	2	3	98	270	524	224	80
Acetes sp.	58	46	-	316	-	-	130
	121	121	128	2596	52	214	2244
	90	76	40	2176	-	188	1862
	74	56	10	1944	-	104	1516
Others	-	5	16	-	62	24	10
	1	2	60	-	24	22	18
	1	8	60	38	42	84	54
	-	4	22	26	40	90	56

saline areas but also at Malancha among freshwater-influenced sites due to the effect of sewage effluents. Other organisms like crabs, worms, and polychaets, were low at Kakdwip and Bakkhali due to wanton destruction of mangroves and for improper tidal flow respectively. Among associated fauna, *P. monodon* concentration declined a little due to rise in the quality of *M. brevicornis* seed.

Considering the heterogenity of the ecosystem within the Sunderbans and the utility of mangroves for the growing fishes and shrimps, biochemical analysis of fish, shrimp, mangrove litters, and detritus from four zones *viz.*, (a) *Avicennia*-infested, (b) *Cariops* -infested, (c) *Excoecaria* -infested and (d) *Phcenix* - infested were taken up. The details are given in Tables 4, 5 and 6. In the process of detritus formation from litters, both the protein and the energy contents increased and the carbohydrate content declined; the fat content remaining somewhat constant. *Phoenix* sp. dominated the area and provided the least nutrients to shrimp and fish for higher crude fibre content.

Water bodies under mangrove vegetation were generally productive but the bottom sediments, particularly of Bakkhali, were not capable of supporting good growth of heterotrophic bacteria, phosphate stabilizing bacteria, aerobic nitrogen fixing bacteria, and actinomycetes, probably due to sandy soil with poor nutrients. Negative response was noted in respect of *E. coli* in these water bodies. However, nutrient enrichment of the system took place through bacterial decomposition of mangrove litters.

Physico-chemical characteristics of water after 15 days of incubation with mangrove plant litters are described below :

PHYSICO-CHEMICAL CHARACTERISTICS OF WATER AFTER 15 DAYS OF INCUBATION OF 65 GRAM OF WET-LEAVES OF MIXED MANGROVE PLANT OF BAKKHALI CREEKS IN DISTILLED WATER

Parameters		
1.	Temperature range	29.5° - 30.5°C
2.	pH	6.7
3.	Carbondioxide (CO_2)	200.0 ppm
4.	Bicarbonate (HCO_3)	630.0 ppm
5.	Hardness	590.0 ppm
6.	Nitrogen (NH_4^+-N + NO_3^- - N_3^-)	16.8 ppm
7.	Phosphate-Phosphorus (PO_4-P)	1.4 ppm
8.	Calcium	220.0 ppm

TABLE - 4. WHOLE BODY COMPOSITION OF FISH AND SHRIMP CAUGHT FROM DIFFERENT MANGROVE ZONES

Fish/shrimp sample from the zones of	Fish/shrimp	Moisture	Protein	Total carbohydrate (% drt wt,)	Limpd	Ash
Avicennia	P. indicus	74,3	66.4	8.7	6.3	18.6
	L. parsia	78.2	68.4	13.9	7.2	10.5
Ceriops	P. indicus	74.9	63.2	8.2	6.0	22.6
	L. parsia	79.1	67.3	13.2	7.1	12.4
Excoecaria	P. indicus	73.8	67.5	9.3	6.9	16.3
	L. parsia	78.0	69.4	14.6	8.9	7.1
Phoenix	P. indicus	73.2	61.8	7.3	5.9	25.0
	L. parsia	79.6	66.0	14.1	6.9	13.0

TABLE - 5. PROXIMATE CHEMICAL COMPOSITION AND CALORIC CONTENTS OF THE LEAVES OF MANGROVES

Species of plant	Moisture	% Dry Wt.					
		Protein	Fat	N.F.E	Crude fibre	Ash	Energy (K cal)
Avicennia marina	68.2	18.6	9.0	27.0	23.0	22.4	355
Ceriops dacandra	61.3	16.6	7.3	20.5	24.7	26.9	328
Excoecaria agallocha	73.6	19.2	8.6	29.5	25.6	17.1	374
Phoenix paludosa	54.7	14.8	6.9	20.5	30.1	27.7	323

TABLE - 6. PROXIMATE CHEMICAL COMPOSITION OF THE DETRITUS OF MANGROVE

Detectable decompost of	Protein (%)	Lipid (%)	Total carbohydrate (N.F.E. + Crude Fibre) (%)
	DRY WT. COMPOSITION		
Avicennia	22.3	9.3	38.1
Ceriops	19.1	7.9	36.9
Excoecaria	25.4	9.1	40.3
Phoenix	17.3	7.0	38.2

PROJECT BF/B/9

ECOLOGY AND FISHERIES OF NARMADA ESTUARINE SYSTEM WITH SPECIAL REFERENCE TO PROPOSED IMPOUNDMENT OF RIVER NARMADA (SARDAR SAROVAR)

Personnel : D. Nath, S.N. Singh, S.K. Sarkar, K.S. Banerjee

Duration : 1988-1993

Location : Vadodara

Pre-impoundment survey of the lower estuarine zone and the upper reaches of river Narmada, initiated in 1987, was completed during 1988. Besides the investigations on fisheries and breeding of *Tenualosa ilisha* in river Narmada, a pre-impoundment survey report incorporating the details on hydrological features of the river Narmada, water quality, biological characteristics, fishery resources and the fishing gears used was prepared and sent to the Commissioner of Fisheries, Govt. of Gujarat.

Tenualosa ilisha contributed about 33% of the total catch of 12,064 metric tonnes during 1987-88. The other important fishery mainly comprised the prawn *Macrobrachium rosenbergii*. In the lower zone, fish species *viz. Harpodon nehereus, Hilsa toli, Pama pama, Liza* spp., *Arius* spp. and miscellaneous prawn species formed the major catch. The total fish catch including *Tenualosa ilisha* from the lower zone contributed 73-75% to the total landings.

Investigations on ecological parameters including primary productivity are in progress. Primary productivity in a stretch of 150 km ranged between 59.0-120.9 mg C m^{-3} hr^{-1} (average 87.086 mg C m^{-3} hr^{-1}). Higher values of primary productivity (120.0 mg C m-3 hr^{-1}) and densities of planktonic (697 X 10^3 m^{-3}) and benthic populations (4,980 unit m^{-2}) were recorded around Bharuch indicating high organic load in the lower stretch of river Narmada. The studies are being continued.

PROJECT BF/A/2

FISHERY AND BIOLOGY OF HOOGHLY HILSA, *TENUALOSA ILISHA*

Personnel : D.K. De, B.N. Saigal, M.K. Mukhopadhyay, M.J. Bhagat, Amitabha Ghosh, H.C. Joshi, V.K. Unnithan, P.M. Mitra, Ansuman Hajra, P.K. Chakrabarti, A.B. Mukherjee

Duration : 1986-90

Location : Estuarine Division, Barrackpore with sampling centres at Uluberia, Diamond-Harbour, Digha, Frazergunj and Farakka

(i) Fishery : The estimated total hilsa landings from the Hooghly estuary amounted to 1,215 t during the period January 1988 to December 1988. In addition, the juvenile hilsa fishery from the freshwater stretches yielded an estimated catch of 44.9 t during the period.

(ii) Trend in migration : Maximum hilsa catches were obtained during August to October. As regards the size and age composition of migratory hilsa, the fishery was contributed to the extent of 75% by the individuals belonging to size ranges 341-420 mm (3rd yr.), 421-460 (4th yr.) and 461-500 (5th yr.) forming 41, 17 and 7% respectively by numbers.

(iii) Larval abundance : Studies on larval abundance of hilsa in the freshwater zone of the Hooghly estuary indicated its prolonged spawning season from October to February with peak in October, November and February (Table 1).

TABLE - I. AVAILABILITY OF HILSA SEED IN THE FRESHWATER STRETCH OF HOOGHLY ESTUARY DURING 1988-89

Month	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Max. no. of seed per shooting net per hr.	16	130	46.7	39	45	164	37	93	Not available
Av. no. of seed per shooting net per hr	10.6	55.4	66.6	19.2	23.4	34.5	11.4	23.2	Not available

(iv) **Food and feeding habits :** In young hilsa (20-95 mm) the major component of the stomach contents were copepods followed by rotifers.

Histology

The mucous cells of the alimentary canal have been found to be AB positive. AB positive mucous has also been detected from posterior stomach.

Racial studies : Electrophoresis of blood serum protein of hilsa using acrylamide gel has shown distinct differences in distribution pattern and the density of amino acid bands between the hilsa population of the Bhagirathi, the Hooghly and the Ganga below the Farakka Barrage.

Proximate composition : Studies on moisture, protein and lipid content of muscle and gonads of hilsa at different places of Hooghly estuary and downstream of Farakka Barrage of River Ganga indicated that almost similar protein values were observed for the fishes obtained from both the water bodies. The mature hilsa collected from Farakka showed 9.2% lipid in muscle and 20.9% in gonad.

Heavy metal accumulation in tissues : Estimation of heavy metal concentration was carried out in the muscle, liver and gonadal tissues of the hilsa collected from different centres of the Hooghly estuary. Accumulation of heavy metals in tissues showed higher levels in the small sized hilsa probably due to their habitual stay in the freshwater stretch of the estruary (Table 2) and more exposure to the contaminated environment.

TABLE - 2. ACCUMULATION OF HEAVY METALS (µg per wet wt.) IN TISSUES OF HILSA OF HOOGHLY ESTUARY

Nature of	Size of fish	Zn ($\mu g\ g^{-1}$)	Cu ($\mu g g^{-1}$)	Cr ($\mu g\ g^{-1}$)	Cd ($\mu g\ g^{-1}$)	Pb ($\mu g\ g^{-1}$)	Hg ($\mu g\ g^{-1}$)
Muscle	Fry	28.9	-	-	-	-	0.076 to 0.081
-do-	Juvenile	8.4-9.8	-	-	-	-	-
-do-	Adult	5.2	3.73 to 5.24	0.89 to 3,10	0.41	1.84 to 5.89	0.024 to 0.0356

Liver	Adult	9.9 to 22.2	Nil to 4.19	Nil to 0.38	0.33	2.08	-
Gonad	Adult	20.8 to 34.3	4.4 to 10.5	0.4 to 7.3	0.4 to 1.0	2.69 to 15.2	0.13

Studies on fish lock at Farakka Barrage : The velocity of flow through the fish locks and the adjoining areas was observed to be tremendously non-steady and turbulent at the downstream point. The lock geometry perhaps offered excessive resistance to the river flow causing frequent eddies during the monsoon flood when the river flow level was 2.59 m above the maximum water level. The velocity of river flow varied between 3.5 and 4.87 m $sec.^{-1}$ at about 500 m down the barrage.

Artificial fecundation and culture of hilsa : Successful artificial fecundation of hilsa was conducted in the Ganga-Padma river stretch just downstream of Farakka Barrage during the month of October and November 1988 (Table 3). Incubation of developing eggs in the laboratory conditions gave a better percentage of hatching and survival. Methods of transport of hilsa hatchlings were also evolved. The hatchlings survived for 15 days under pond condition.

A new glass hatchery was fabricated for incubation, hatching and partial rearing of hilsa. The hatchery consists of a set of round glass jars, containers to collect the hatchlings and an overhead tank.

TABLE 3. RESULTS OF EXPERIMENTS ON ARTIFICIAL FECUNDATION OF *T. ILISHA* DURING 1988 AT FARAKKA

Exp. No.	Date of stripping	Size of male in g	Size of female in g	% of fertilisation	% of hatching	Total production of hatchlings
1	15.10.88	i) 600 ii) 700	1100	Not fertilised	-	-
2	16.10.88	i) 650 ii) 500	850	60	30	4,000
3	17.10.88	i) 500 ii) 750	550	Not fertilised	-	-

4	18.10.88	i) 800 ii) 450 iii) 500	1000	Not fertilised	-	-
5	21.10.88	i) 600 ii) 550 iii) 400	900	80	50	10,000
6	23.10.88	i) 750 ii) 450 iii) 500	1200	90	75	60,000
7	16.11.88	i) 450 ii) 525	850	80	Before hatching all perished	-
8	17.11.88	i) 600 ii) 550	700	75	50	8,000
9	18.11.88	i) 700 ii) 450	750	95	60	30,000

PROJECT **AN/A/7**

ECOLOGY AND PRODUCTION BIOLOGY OF EDIBLE INLAND MOLLUSCS

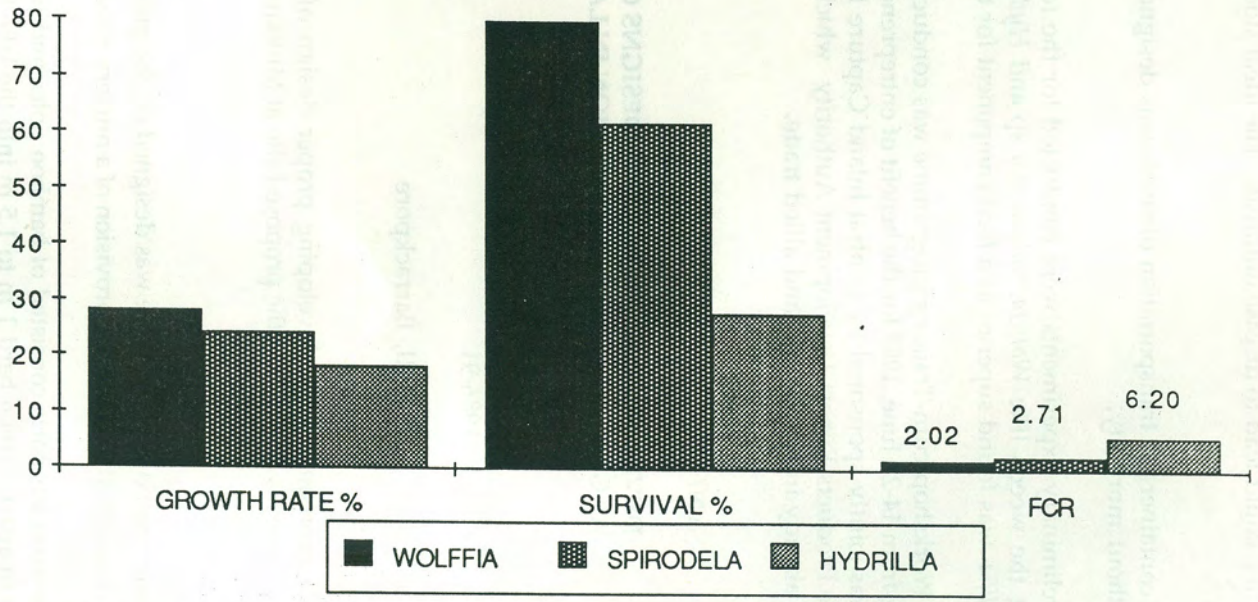
Personnel : G.K. Vinci, V.K. Unnithan, V.V. Sugunan, H.C. Joshi and A. Hajra

Duration : 1984-89

Location : CICFRI, Barrackpore

A low-cost model, open field snail farm (5 m X 4 m) was constructed with a drain (20 X 30 cm) around the plot. The drain was filled with water to prevent the snails from escapement. The plot was provided with shady plants, hollow wooden trunks, broken bricks, etc. as shelter for the snails from sun and heavy rain. In the earlier experiment the stocking density @ 200 nos per m^2 was found suitable. Subsequent experiments, proved that

FIG I FEED EFFICIENCY TRIALS ON ACHATINA FULICA



overcrowding could lead to disease outbreak. The ideal stocking density was worked out as 100 nos. m^{-2}.

A container for transportation of snails was designed to carry live snails to distant places without mortality.

Preliminary experiments were conducted for the formulation of a cheap balanced diet using the weeds like *Wolffia, SpirodelLa* sp and *Hydrilla*. The results are given in Fig. I. *Wolffia* was found superior as a feed component for the snails.

A Workshop-cum-Training programme was conducted in snail capture, culture and processing from 14-22 June, 1988 for the benefit of entrepreneurs and seafood exporters. The training was jointly sponsored by Central Inland Capture Fisheries Research Institute and the Marine Products Export Development Authority which was attended by 23 exporters who were already in the seafood and allied trade.

PROJECT AN/A/9

DEVELOPMENT OF SUITABLE DESIGNS OF PENS AND CAGES FOR AUGMENTING FISH PRODUCTION IN LAKES AND RESERVOIRS

Personnel : A.B. Mukherjee

Duration : 1986-91

Location : CICFRI, Barrackpore

As a prerequisite for developing proper design of a net pen enclosure, detailed engineering survey was made at the proposed site at Muktapur ox-bow lake.

Design

The proposed pen enclosure was designed on the principle of a flexible structure that covered an area of 600 m^2 with the provision of a nursery pond of 90 m^2.

The main supports consisted of bamboo poles and inclined guys each of 15 cm dia. spaced at 1 m apart, driven hard 1 m to 1.5 m into the lake bed for sufficient skin frictional resistance to keep the posts in equilibrium. The bamboo mat screens spanned across the vertical supports and were adequately strengthened by fixing with half split bamboo horizontals and inclined bracings. The fish net enclosure was to be fixed on the matting with its tail-end held securely in the mud base.

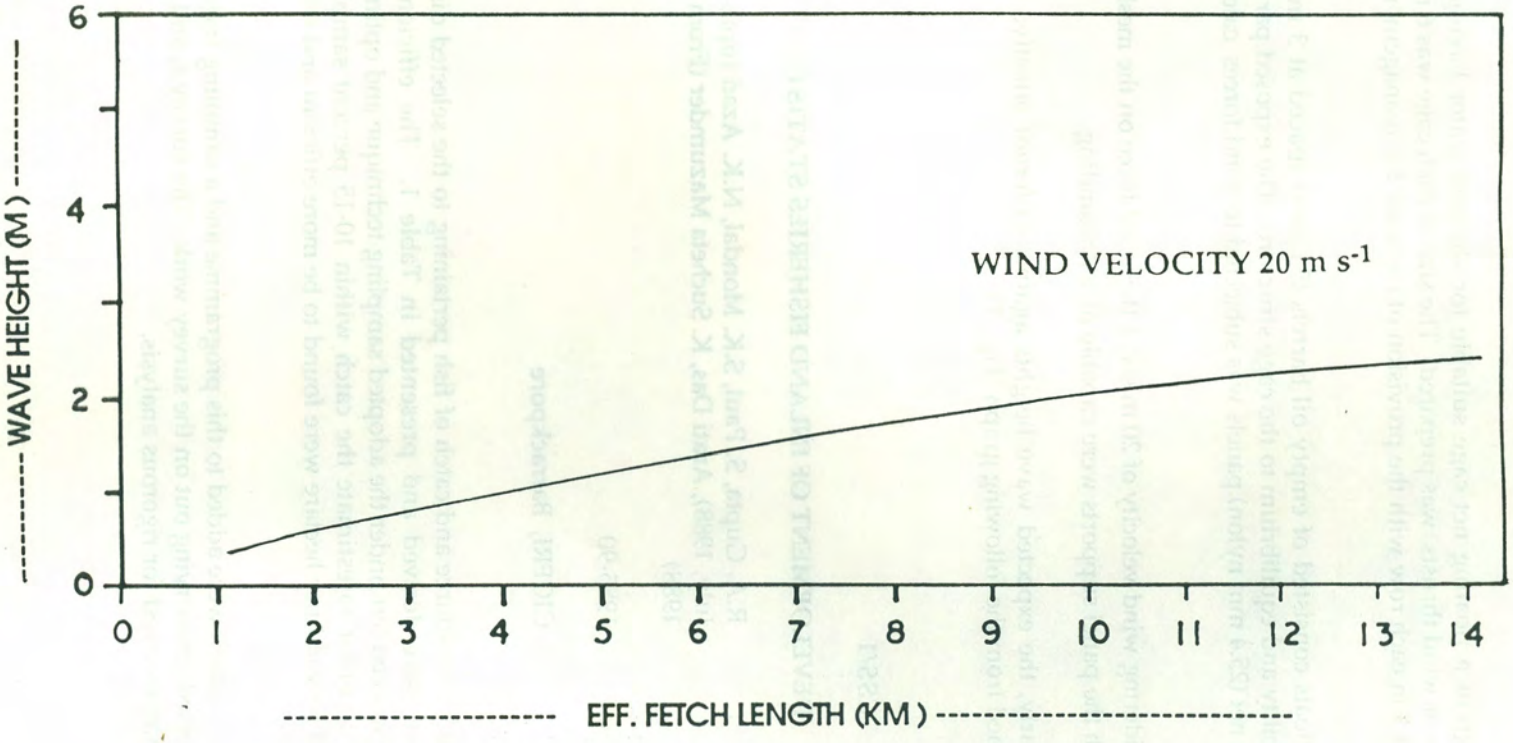


FIG. 1 SIGNIFICANT WAVE HTS. FOR VARIOUS FETCH LENGTHS

The net cage

Design of a floating net cage suitable for shallow water having less exposure to severe storms or wind thrusts was prepared. The size of each cage was 6 m X 4 m X 2.8 m, 6 nos. arranged 3 in each row with the provision of cat walk for management and operational facilities.

The floats consisted of empty oil barrels (50 gals) spaced at 3 m apart to provide adequate stability and equilibrium to the cage structure. The exposed part of the polymeric fish retention net (25.4 mm nylon) panels was subjected to wind forces calculated from - $F = 0.0186\ AV^2$.

Considering wind velocity of 20 m sec,-1 the wind force on the mesh net came to 7.44 kg m^{-2}, which the panel supports were capable of withstanding.

Similarly, the expected wave heights against different effective fetch length was been determined from the following graph (Fig. 1).

PROJECT CSS/1

DEVELOPMENT OF INLAND FISHERIES STATISTICS

Personnel : R.A. Gupta, S. Paul, S.K. Mondal, N.K. Azad (upto July, 1988), Arati Das, K. Sucheta Mazumder (From November, 1988)

Duration : 1985-90

Location : CICFRI, Barrackpore

Estimates of resource and catch of fish pertaining to the selected districts under the sampling frame were derived and presented in Table 1. The efficiencies of various estimates were worked out under the adopted sampling technique and optimum sample size was estimated in order to estimate the catch within 10-15 percent sampling error. The estimates based on yield per hectare were found to be more efficient and reliable than other statistics.

Eight new states were added to this programme and a sampling frame was prepared and sample selected for carrying out on the survey work. The survey is still in progress and the data are being received for rigorous analysis.

PUBLICATIONS 1988-89

Babu Lal 1988

Use of radio-isotopes and ^{14}C in the productivity studies of inland waters. In *Conservation and Management of Inland Capture Fisheries Resources of India*, eds. Arun G. Jhingran & V. V. Sugunan, Inland Fisheries Society of India Barrackpore ,India : 239-244

Bagchi, M.M. & B.B. Ghosh 1986

Role of tidal influence on the degree of industrial pollution caused by sulphite pulp and paper mill waste in the Hooghly estuary near Hazinagar. *Proc. Symp. Coastal Aquaculture*, 4 : 1316-1329.

Bali, Usha 1988

Histochemical study of the neurosecretory centres and their tract in the snow trouts *Schizothorax niger* Heckel. *Indian J. Anim. Sci.*, *58*(4) : 522-528.

Banerjee, R.K. 1988

Man induced environment deterioration in the Damodar river system. In *Conservation and Management of Inland Capture Fisheries Resources of India*, eds. Arun G. Jhingran & V. V. Sugunan, Inland Fisheries Society of India Barrackpore ,India : 91-95

Banerjee, R.K. & B.B. Pakrasi 1986

Physico-chemical nature and biomass production of newly constructed brackishwater impoundments (Nona Gheri) in the lower Sunderbans. *Proc. Symp. Coastal Aquaculture*, 4 : 1103-1106.

Banerjee, R.K. & K.V. Srinivasan 1988

Recycling - reuse of penicillin mycelium as fish pond manure. *Biological Waste*, 23(2) : 107-116.

Barrackpore, Central Inland Capture Fisheries Research Institute & National Research Centre on Coldwater Fisheries, Haldwani 1988

Report on impact of construction and completion of Beas Project (Stage I - Beas-Sutlej link & Stage II - Pong Dam) on Limnology and Fisheries of River Beas, 45p. (Under Coordinated Project on Assessment of Environmental Impact of Beas-Sutlej Link Project, Govt. of India, Ministry of Environment and Forests, New Delhi by K.L. Sehgal).

Bhagat, M.J. & S.N. Dwivedi 1988
Impact of the exotic fish *Oreochromis mossambicus* on the indigeneus fishery of Powai lake, Bombay.
J. Indian Fish. Asso., **18** : 511-515.

Bhagat, M.J. & S.N. Dwivedi 1988
Limnological studies of a freshwater tropical impoundment - Powai Lake I. Morphometry and physical features.
J. Indian Fish. Asso., **18** : 529-536.

.Bhagat, M.J. & Shyam Sunder 1983
A preliminary note on length-weight relationship and relative condition factor of *Schizothorax plagiostomus* (Heckel) from Jammu region.
J. Inland Fish. Soc. India, 15(1-2) : 73-74.

Bhagat, M.J. & Shyam Sunder 1984
Some biological aspects of *Schizothoraichthys esocinus* (Heckel) from Kashmir waters with a note on its utility in culture.
J. Inland Fish. Soc. India, 16(1-2) : 42-47.

Bhagat, M.J. ,Shyam Sunder & R.K. Langer1989
Organic production in relation to ecology and fish yield of Dal lake, Kashmir.
In Recent Advance in Fish Ecology, Limnology and Eco-conservation, ed. by Surendra Nath, Creative Publishers, New Delhi, 1988 : 58-63.

Bhowmick, M.L., R.K. Chakraborti, S.K. Mondal & Apurba Ghosh 1987
Effect of monsoon on the culture of tiger shrimp *Penaeus monodon* (Fabricius).
J. Indian Soc. Coastal agric. Res., 5(1) : 287-291.

Chakraborti, N.M., P.K. Chakraborti & Apurba Ghosh 1987
Carnivorous fishes and their culture possibilities in coastal areas.
J. Indian Soc. Coastal agric. Res., 5(1) : 307-311.

Chakraborti, P.K. & A.K. Bandopadhyay 1987
A study on rice fish culture in coastal saline soils.
J. Indian Soc. Coastal agric. Res., 5(1) : 245-249.

Chakraborti, P.K. & G.N. Chattopadhyay 1988
Impact of Farakka Barrage on the estuarine ecology of the Hooghly-Matlah system . In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India ,Barrackpore ,India : 189-196

Chakraborti, P.K. & K.R. Naskar 1988
Role of mangrove in estuarine fisheries development. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India ,Barrackpore ,India : 229-233

Chakraborti, R.K., M.L. Bhowmik & Apurba Ghosh 1987
On a new method for nursery rearing of *Penaeus monodon* (FAB) at high stocking density.
J. Indian Soc. Coastal agric. Res., 5(2) : 427-429.

Chakraborti, R.K., Kuldip Singh, A.K. Roy & D.D. Halder 1987
Observations on productivity of brackishwater ponds with special reference to triculture.
J. Indian Soc. Coastal agric. Res., 5(1) : 251-255.

Chandra, Ravish 1988
Riverine fisheries resources of the Ganga and Brahmaputra. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India ,Barrackpore ,India : 52-60

Chattopadhyay, G.N. & L.N. Mondal 1986
A study on the physico-chemical characteristics of some brackishwater fish pond soils of West Bengal.
Proc. Symp. Coastal Aquaculture, **4** : 1053-1058.

Chattopadhyay, G.N. & R.K. Chakraborti 1986
A comparative study on the nature and properties of some brackishwater and nearby freshwater fish pond soils.
Proc. Symp. Coastal Aquaculture, **4** : 1110-1114.

Chattopadhyay, G.N., Apurba Ghosh, C.R. Biswas & P.K. Chakraborti 1988
Rice-fish culture in high rainfed coastal saline soils.
Proceedings of first Indian Fisheries Forum, Dec.4-8, 1987, Mangalore, Karnataka, ed. by M. Mohan Joseph, Asian Fisheries Society, Indian Branch, Mangalore : 135-37.

Chattopadhyay, G.N., P.K. Saha, Apurba Ghosh & H.C. Karmakar 1988
A study on optimum BOD levels for fish culture in waste water ponds.
Biological Waste, **25**(2) : 79-85.

Chitranshi, V.R. 1988
Pen and Cage Culture of Fish in ox-bow lakes. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India ,Barrackpore ,India : 148-150

Das, M.K., R.N. Pal & P.B. Das 1987
Preliminary observations on the ecology of animal parasites in estuarine fishes of Deltaic West Bengal.
J. Indian Soc. Coastal agric. Res., 5(1) : 319-323.

Das, P., J.G. Chatterjee, A.B. Mondal & D.P. Chakraborty 1987
Prospects of carp culture in lower Sunderbans.
J. Indian Soc. Coastral agric. Res., 5(2) : 453-459.

Das, P., U. Bhaumik, P.K. Pandit, B. Roy, B.K. Banerjee & S.K. Mondal 1988
Some variables contributing to the adoption of composite fish culture innovations. Proceedings of first Indian Fisheries Forum, Dec.4-8, 1987, Mangalore, Karnataka, ed. by M. Mohan Joseph, Asian Fisheries Society, Indian Branch, Mangalore : 467-470.

De, D.K., Amitabha Ghosh & V.K. Unnithan 1988
Biology and migration of Hooghly hilsa in the context of Farakka Barrage. In *Conservation and Management of Inland Capture Fisheries Resources of India*, eds. Arun G. Jhingran & V. V. Sugunan, Inland Fisheries Society of India ,Barrackpore , India : 197-202

Ghosh, Ajoy Kumar 1987
A note on cestode *Liguea* sp. found in the viscera of *Catla catla* (Ham.) in a pond near Puri coast.
J. Indian Soc. Coastal agric. Res., 5(1) : 231-233.

Ghosh, A.K. & N. Sarangi 1987
Occurrence of the isopod parasite, *Palaegyge bengalensis* (Bopyridia : Isopoda : Crustacea) on a hitherto unknown *Macrobrachium malcolmsonii* (Decapoda) (Crustacea) in Orissa.
J. Indian Soc. Coastal agric. Res., 5(1) : 235-236.

Ghosh Amitabha, K.M. Das & Apurba Ghosh 1987
Morphohistology of the digestive tract of a mullet, *Liza parsia* (Ham.) in relation to its food habits.
J. Indian Soc. Coastal agric. Res., 5(2) : 437-444.

Ghosh, Amitabha, M.J. Bhagat, G.N. Chattopadhyay, G.K. Vinci, A.R. Chaudhury & B.N. Saigal 1984
Ecological investigations in a jute retted pond under pisciculture.
J. Inland Fish. Soc. India, 16(1 & 2) : 7-10.

Ghosh, Apurba 1988
Recycling of sewage effluents through fish production - a means to combat riverine pollution. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India ,Barrackpore , India : 69-74

Ghosh, Apurba, Amitabha Ghosh, P.K. Chakraborti, A.K. Roy & G.N. Chattopadhyay 1987
Studies on food habits of *Lates calcarifer* (BL) in sewage enriched pond stocked with *Oreochromis mossambicus.*
J. Indian Soc. Coastal agric. Res., 5(2) : 445-451.

Ghosh, Apurba, G.N. Chattopadhyay & A.B. Mukherjee 1988
A modular project for recycling sewage effluents through aquaculture and its viability.
In Industrial Seminar on Waste Watser Reclamation and Reuse for Aquaculture, 6-9 Dec. 1988 organised by Economic and Social Commission for Asia and the Pacific, Ministry of Agriculture, Govt. of India & Dept. of Fisheries, Govt. of West Bengal : 29-34.

Ghosh, Apurba, G.N. Chattopadhyay, Amitabha Ghosh & R.K. Das 1988
Fisheries resources management of sewage-fed wetlands of Calcutta spill area. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 210-215

Ghosh, Apurba, G.N. Chattopadhyay &P.K. Chakraborti 1988
Environmental and sanitary aspects of wastewater recycling for productive use.
In Industrial Seminar on Waste Watser Reclamation and Reuse for Aquaculture, 6-9 Dec. 1988 organised by Economic and Social Commission for Asia and the Pacific, Ministry of Agriculture, Govt. of India & Dept. of Fisheries, Govt. of West Bengal : 7-13.

Ghosh, B.B., H.C. Joshi & M.M. Bagchi 1988
Impact of pollution in Hooghly-Matlah estuarine system. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 203-209

Ghosh, B.B., M.M. Bagchi & D.K. De 1983
Some observations on the status of pollution in the Hooghly estuary (West Bengal) with reference to heavy metrals disposed through industrial wastes.
J. Inland Fish. Soc. India, 15(1-2) : 44-53.

Ghosh, B.B., M.M. Bagchi & S.B. Saha 1986
Effect of industrial pollution by soda process pulp and paper mill waste on the primary productivity of the Hooghly estuary near Tribeni.
Proc. Symp. Coastal Agriculture, 4 : 1386-1395.

Gopalakrishnayya, Ch. 1988
Some considerations in management of coastal lagoons with special reference to fisheries of the Chilka, the Pulicat and the Vembanad lakes. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 234-238

Govind, B.V. & P.K. Sukumaran 1988
Tank fishery resources of India. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 156-161

Govind, B.V., P.K. Sukumaran, S.L. Raghavan & M.F. Rahman 1983
Composite fish culture in larger freshwater tanks in and around Bangalore.
J. Inland Fish. Soc. India, **15**(1-2) : 54-60.

Gupta, R.A. 1988
Role of sampling theory in stock assessment in inland capture fisheries. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 178-182

Gupta, R.A., S. Paul & S.K. Mondal 1988
Collection and estimation methodology of Inland Fisheries Statistics in India - a manual.
Bull. Cent. Inland Capture Fish. Res. Inst., **No.58.**

Hajra, Ansuman 1988
Studies on the diet and digestive rate in predator species - a method employing dual applications of disc-gelelectrophoresis and densitometric scanning. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 252-256

Hajra, Ansuman, Apurba Ghosh & Sanat Kumar Mondal 1988
Biochemical studies on the determination of optimum dietary protein to energy ratio for tiger prawn, *Penaeus monodon* (Fab.) juveniles.
Aquaculture, **71**(1-2) : 71-79.

Halder, D.D., Utpal Bhaumik, P.K. Pandit & J.G. Chatterjee 1988
Fish mix with food.
Indian Fmg., 38(8) : 28-29.

Halder, D.D., U. Bhaumik, P.K. Pandit & J.G. Chatterjee 1988
Role of extension in the inland capture fisheries research. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 271-275

Jhingran, Arun G. 1988
Potential and scope for development of inland capture fisheries resources of India. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 7-19

Jhingran, Arun G. 1988
Reservoir Fisheries in India.
J. Indian Fish. Asso., 18 : 261-275.

Jhingran, Arun G. 1988
Role of exotic fishes in capture fishery waters of India. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 126-133

Jhingran, Arun G. 1988
Some perspectives in development and management of inland fishery resources of the north eastern region of India.
In DST Workshop on Role of Science and Technology in the Development of North-East India (15-17 Feb. 1988) organised by the School of Science, ManipurUniversity, Imphal.

Jhingran, Arun G. & Apurba Ghosh 1987
Aquafarming in coastal India.
J. Indian Soc. Coastal agric. Res., 5(1) : 195-203.

Jhingran, Arun G. & Apurba Ghosh 1988
Productive utilization of sewage effluent through aquaculture - a case study.
In Industrial Seminar on Waste Water Reclamation and Reuse for Aquacudlture, 6-9 Dec. 1988 organised by Economic and Social Commission for Asia and the Pacific, Ministry of Agricudlture, Govt. of India & Dept. of Fisheries, Govt. of West Bengal, : 7-13.

Jhingran, Arun G. & H.C. Joshi 1987
Heavy metals in water sediments and fish in the River Yamuna.
J. Inland Fish. Soc. India, 19(1) : 13-23.

Jhingran, Arun G. & V.K. Unnithan 1988
Aspects of Inland water management for fisheries.
Journal of the Indian Centre for Public Health and *Environment, Special lissue*, 1988-89 : 9 p.

Jhingran, Arun G. & V.K. Unnithan 1988
Matsya palan ke liye antorsthaliya jala vyavastha (Inland fishery management for fish culture).
Parti Bhumi Samachar, No.4, Oct.-Dec. : 7-11.

Joshi, H.C. 1987
Effect of low levels of DDT on a gastropod mollusc ,*Lymnaea luteola.*
In Trends in Environmental Pollution and Pesticide Toxicology : Proceedings of 8th Annual Session of Academy of Environmental Biology, lheld at University of Jammu from Dec. 10-12, 1987, ed. by Shashi Kant : 349-354.

Joshi, H.C. 1988
Impact of man - made environmental modifications on the riverine ecology and productivity - a case study of the River Ganga. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 80-90

Khan, M.A. 1988
Biology of *Labeo calbasu* (Ham-Buch) from Tilaiya reservoir, Bihar. 1. length-weight relationship, condition index and feeding habits.
Proc. Nat. Acad. Sci. India, 58 B(1) : 41-47.

Khan, M.A. 1988
Production biology of riverine fishes. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 42-51

Khan, M.A., R.A. Gupta & M. Peer Mohamed 1987
Effect of D.D.T. and Aldrine on survival and reproduction of *Ceriodaphnia cornvta* Sar (Cladocera : Daphni dae).
In Trends in Environmental Pollution and Pesticide Toxicology : Proceedings sof 8th Annual Session of Academy of Environmental Biology, held at University of Jammu from Dec. 10-12, 1987, ed. by Shashi Kant : 185-190.

Kumaraiah, P., S. Parameswaran & P.K. Sukumaran 1986
Culture of Tilapia *Oreochromis mossambicus* (Petres) In cages.
In Proc. Natl. Symp. Fish & Env., : 145-147.

Kumar, D., B.K. Mishra & R.K. Dey 1986
Dropsy in *Catla catla* (Ham.) caused by mixed infection of *Aeromonas hydrophila* and *Myxosporidian sp.*
Aquaculture Hungarica (Szarvas), **5** : 107-112.

Kumar, D., J. Farkas & V.R.P. Sinha 1986
Bacteria from diseased freshwater fishs of India.
Aquaculture Hungarica (Szarvas), **5** : 113-118.

Laal, A.K., A. Sarkar & K.L. Shah 1983
Species diversity of periphyton in a polluted pond at Bhagalpur, Bihar.
J. Inland Fish. Soc. India, **15**(1-2) : 75-76.

Laha, G.C., H.C. Karmakar, Ajoy Kumar Ghosh & S.K. Mondal 1988
Seed estimation and abundance of commercially imoportant prawn - *Penaeus monodon* Fabricieus and *Macrobrachium rosenbergii* DeMan in West Bengal.
J. Indian Soc. Coastal agric. Res., **6**(1) : 65-73.

Mondal, S.K. & M.L. Bhowmik 1984
Prawn seed collection and developing seed trade in Sunderbans.
J. Inland Fish. Soc. India, **16**(1-2) : 51-52.

Mondal, S.K., M.L. Bhowmick, R.k. Chakraborty & D. Sanfui 1987
A note on salinity tolerance of *Liza parsia* (Ham.).
Nat. Acad. Sci. Litters, **10**(8) : 291-295.

Mondal, S.K., P.M. Mitra & H.C. Karmakar 1988
Methods of studying the population dynamics of estuarine fishes. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 245-251

Mukherjee, A.B. 1988
Engineering aspects of cage and pen designs. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 151-155

Mukherjee, A.B. & Apurba Ghosh 1987
Engineering aspects of designing prawn farms in tidal regions of Sunderbans.
J. Indian Soc. Coastal agric. Res., **5**(1) : 257-265.

Mukhopadhyay, M.K., B.B. Ghosh & M.M. Bagchi 1987
Preliminary observations on the impact of some industrial wastes on prawn fisheries of Hooghly estuary.
J. Indian Soc. Coastal agric. Res., 5(1) : 293-296.

Murugesan, V.K. & P. Kumariah 1984
A simple technique for mass breeding of murrels.
J. Inland Fish. Soc. India, 16(1-2) : 15-18.

Naskar, Kumudranjan & D.N. Guha Bakshi 1987
Different phyto-ecological zones in the 24-Parganas district of West Bengal with special reference to its land utilization patterns.
J. Indian Soc. Coastal agric. Res., 5(1) : 183-187.

Naskar, Kumudranjan & S.C. Santra 1987
A note on Enteromorpha tubulosa in brackish mixed sewage fed fisheries from Sunderbans in West Bengal.
J. Indian Soc. Coastal agric. Res., 5(2) : 471-472.

Naskar, Kumudranjan & S.K. Saha 1988
Utilization of domestic wastes for integrated farming in the tropics.
J. Aqua Trop., 3(1) : 37-41.

Naskar, Kumudranjan, S.K. Saha & A.K. Datta 1988
Utilization of domestic waste water for rice production.
Environ. & Ecol., 6(1) : 125-128.

Nath, D. 1983
Nature and duration of toxicity and hydrological changes after application of mahua oilcake in fish ponds.
J. Inland Fish. Soc. India, 15(1-2) : 69-72.

Pakrasi, B.B., S.C. Banerjee & R.K. Banerjee 1986
Ecology of culture ponds in coastals region of Sunderbans.
Proc. Symp. Coastal Aquaculture, 4 : 1425-1428.

Pal, R.N. & H.P. Singh 1983
Preliminary observations on some limnological parameters of an acidic swamp in Guwahati, Asam.
J. Inland Fish. Soc. India, 15(1-2) : 28-35.

Pal, R.N., A.K. Ghosh & M.K. Das 1988
Common fish parasites encountered in estuarine wetlands and their codntrol measures. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 216-222

Pal, R.N., H.C. Karmakar, S.C. Thakurta, G.C. Laha & P.K. Das 1987
Problems of fish health in bheries of the districts North and South 24 Parganas, West Bengal.
J. Indian Soc. Coastal agric. Res., 5(1) : 279-286.

Parameswaran, S. & M.Y. Kamal 1988
Synopsis of biological data on the giant murrel ,*Channa marulius* (Hamilton 1822) the striped murrel ,*Channa striatus* (Bloch 1793) and the spotted murrel *Channa punctatus* (Blicl 1793).
Bull. Cent. Inland Capture Fish. Res. Inst., **No.53,** 90 p.

Pathak, V. 1988
Quantitative assessment of fish productivity in reservoirs through bio-energetics.
Development Ecology, 1(1) : 51-61.

Pathak, V., M.J. Bhagat & K. Mitra 1988
Fisheries potential and management of ox-bow lakes of Ganga and Brahmaputra basins. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 143-147

Paul, S. 1988
Certain issues in economics of production and marketing of inland fish.
In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 261-263

Paul, S. 1988
Project appraisal of aquatic production systems. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 257-260

Paul, S. 1988
Socio-economic dimensions of waste recycling with special reference to sewage-fed fisheries.
In Industrial Seminar on Waste Water Reclamation and Reuse for Aquacudlture, 6-9 Dec. 1988 organised by Economic and Social Commission for Asia and the Pacific, Ministry of Agricudlture, Govt. of India & Dept. of Fisheries, Govt. of West Bengal, : 1-6.

Pillai, S.M., P.K. Ghosh, T. Rajyalakshmi, D.D. Halder, A.K. Roy & R.K. Chakraborti 1987
Production potential of rain fed ponds in coastal aquaculture in Sunderbans.
J. Indian Soc. Coastal agric. Res., 5(1) : 313-318.

Radheysham, S., D. Kumar, V.R.P. Sinha & J. Olah 1986
Dramatic fish kill associated with bacterial bloom in an undrainable fish pond. *Aquaculture Hungarica (Szarvas)*, **5** : 127-132.

Rahman, M.F. 1988
Instance of forked barbels in *Puntius puckelli* (Day) and *Mystus vittatus* (Bloch). *Curr. Res.*, **17**, p.68.

Ramakrishniah, M. 1986
Studies on the fishery and biology of *Pangasius pangasius* (Hamilton) of the Nagarjunasagar reservoir of Andhra Pradesh.
Indian J. Fish., **33**(3) : 320-335.

Ramakrishniah, M. 1986-87
A new bagrid fish of the genus *Mystus* (scopoli) from Krishna river system., *Matsya*, **12-13** : 139-143.

Ramakrishniah, M. 1988
Age, growth and fishery of *Mystus aor* (Hamilton) from Nagarjunasagar reservoir. *In* Proceedings of First Indian Fisheries Forum, Dec. 4-8, 1987, Mangalore, Karnataka, ed. by M. Mohan Joseph, Asian Fisheries Society, Indian Branch, Mangalore : 185-189.

Ramakrishniah, M. 1988
Management norms for large medium and small reservoirs. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 112-118

Roy, A.K., H.C. Karmakar, D.D. Halder & N.M. Chakraborty 1987
Experimental studies on estimating *Liza tade* population from brackishwater ponds.
J. Indian Soc. Coastal agric. Res., **5**(1) : 297-305.

Ray, P. & E. Mitra 1986
Effects of suspensoids on biotic life around the outfall area of a sulphite pulp and paper mill waste in Hooghly estuary.
Proc. Symp. Coastal Aquaculture, **4** : 1377-1385.

Saha, G.N. & A.C. Nandy 1988
Management norms for freshwater and saline bheries. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 223-228

Saha, G.N., S.C. Thakurta & G.C. Laha 1987
Present status of brackishwater bheri fishery in West Bengal with reference to its soil and water qualities, problems and management for improving fish and prawn production.
J. Indian Soc. Coastal agric. Res., 5(1) : 267-271.

Saha, S.B. 1986
Studies on the biotic characteristics in and around the outfall areas of paper mills at Tribeni, Hajinagar and Titagarh, West Bengal.
Proc. Symp. Coastal Aquaculture, 4 : 1359-1366.

Saigal, B.N. & M.K. Mukhopadhyay 1988
Status of estuarine fisheries resources and their exploitation in India. In *Conservation and Management of Inland Capture Fisheries Resources of India*, eds. Arun G. Jhingran & V. V. Sugunan, Inland Fisheries Society of India, Barrackpore, India : 183-188

Saxena, R.K. 1988
Fishing methods in river systems. In *Conservation and Management of Inland Capture Fisheries Resources of India*, eds. Arun G. Jhingran & V. V. Sugunan, Inland Fisheries Society of India, Barrackpore, India : 61-68

Selvaraj, C. & Mathew Abraham 1986-87
Review of the taxonomic status of *Puntius mahecola* (Valenciennes).
Matsya, 12-13 : 20-25.

Selvaraj, C., Mathew Abraham & K. Gopinathan 1987
Validity of fin-clipping to study the growth of Gangetic carps in reservoirs.
J. Inland Fish. Soc. India, 19(1) : 74-77.

Sengupta, A. & D.D. Halder 1988
Selection of site survey design and construction of brackishwater fish farm with special reference to the islands of lower Sunderbans.
Bull. Cent. Inland Capture Fish. Res. Inst. Barrackpore, No. 55, 24p.

Sharma, B.K. & M.K. Das 1988
Integrated fish-live stock - crop farming system.
Proceedings of First Indian Fisheries Forum, Dec. 4-8, 1987, Mangalore, Karnataka, ed. by M. Mohan Joseph, Asian Fisheries Society, Indian Branch, Mangalore : 27-30.

Sharma, B.K. & M.K. Das 1988
Studies on integrated fish - livestock - crop farming system.
Fishing Chimes, 7(11) : 15-27.

Shyam Sunder & K.K. Vass 1988
Seasonal dynamics of benthos in some Kashmir lakes.
Proc. Nat. Acad. Sci. India, 58 B(2) : 193-203.

Singh, Balbir, S.K. Wishard & S.N. Mehrotra 1987
Observations on the breeding of major carps in an improvised nallah of Sumaur, Rewa (Madhya Pradesh).
J. Assam Sci. Soc., 30(1) : 16-21.

Singh, D.N. & R.S. Panwar
Evaluation of toxicity of industrial effluents to the fish *Cirrhinus mrigala* (Ham.).
Journal of Scientific Research, Banaras Hindu University, 36(1-2) : 93-99.

Singh, S.N. 1984
Comparison of planktonic communities of Getalsud reservoir, Ranchi, Bihar.
J. Inland Fish. Soc. India, 16(1-2) : 48-50.

Sivakami, S., S. Ayyappan & M.F. Rahman 1987
Cage culture of silver carp *Hypophthalmichthys molitrix* (Valenciennes) on different feeds.
J. Inland Fish. Soc. India, 19(1) : 37-44.

Sugunan, V.V. 1988
Salient features of reservoir limnology and their significance to fisheries development. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 106-111

Sugunan, V.V. & R.K. Das 1983
Studies on the bottom macrofauna of Nagarjunasagar reservoir, Andhra Pradesh, India.
J. Inland Fish. Soc. India, 15(1-2) : 1-12.

Sukumaran, P.K., S.L. Raghavan & M.F. Rahman 1984
Observations on physiochemical conditions of water and plankton of two tanks in Maland region of Karnataka.
J. Inland Fish. Soc. India, 16(1-2) : 53-55.

Vashist, G.D., T.V. Moorti and P.K. Katiha 1987
An economic evaluation of artificial insemination in Kangra district of Himachal Pradesh.
Asian J. Dairy Res., 6(1) : 26-32.

Vashist, G.D., T.V. Moorti & P.K. Katiha 1984
An economic analysis of artificial insemination in district Kangra. *Agricultural Economics Publication No.23, Dept. of Agri. Eco. , H.P. Krishi Vishva Vidyalaya, Palampur,* Nov. 1984 : 26 p.

Vass, K.K. 1988
Limnology, productivity and fisheries of upland lakes. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 162-168

Vinci, G.K. 1984
Some aspects of the biology of *Silonia childreni* (Sykes) from Nagarjunasagar reservoir, Andhra Pradesh, India. *J. Inland Fish Soc. India,* **16**(1-2) : 25-31.

Vinci, G.K., V.K. Unnithan & V.V. Sugunan 1988
Farming of the giant african snail ,*Achatina fulica* - a manual. *Bull. Cent. Inland Capture Fish. Res. Inst., Barrackpore,* **No.56,** 28p.

Wishard, S.K., S.N. Mehrotra & Balbir Singh 1984
Zeta potential as an indicator of breeding environment for Indian major carps in Bundhs. *J. Inland Fish. Soc. India,* **16**(1 & 2) : 11-14.

Yadava, Y.S. 1988
Riverine floodplain fishery of the Brahmaputra basin. In *Conservation and Management of Inland Capture Fisheries Resources of India* , eds. Arun G . Jhingran & V . V . Sugunan , Inland Fisheries Society of India, Barrackpore, India : 134-142

PERSONNEL

The following scientists rendered their services to the Institute during the period April 1988 to March 1989.

Dr. Arun G. Jhingran, Director, Barrackpore

RIVERINE DIVISION

Allahabad Centre

Shri Ravish Chandra, S-3 (Head)
Dr. S.K. Wishard, S-2
Shri R.K. Saxena, S-2
Shri G.N. Srivasthava, S-2
Dr. D.N. Singh, S-2
Shri Balbir Singh, S-2
Shri R.K. Dwivedi, S-2
Dr. M.A. Khan, S-2
Dr. H.P. Singh, S-2
Shri R.K. Tyagi, S-2
Shri P.K. Katiha, S-1

Lalgola Centre

Shri A.R. Chaudhury, S-1

Bhagalpur Centre

Shri B.L. Pandey, S-1

Guwahati Centre

Shri S.P. Singh, S-3
Dr. Y.S. Yadava, S-2
Shri S.N. Mehrotra, S-2
Shri M. Chowdhury, S-1

Patna Centre

Dr. S.K. Mukhopadhyay, S-3
Shri K.P. Srivastava, S-2
Dr. V.R. Chitransi, S-2
Dr. B.C. Jha, S-2
Dr. V. Pathak, S-2
Dr. P.N. Jaitly, S-1

Agra Centre

Shri D.N. Mishra, S-2
Dr. (Ms.) Usha Moza, S-2
Dr. K. Chandra, S-2
Shri V. Kolekar, S-1

LACUSTRINE DIVISION

Bangalore Centre

Dr. Y. Rama Rao, S-3 (Head)
Dr. D.S. Krishna Rao, S-2
Dr. A.K. Laal, S-2
Shri P.K. Sukumaran, S-1

Eluru Centre

Shri Ch. Gopalakrishnayya, S-3
Dr. R.S. Panwar, S-3
Dr. K.V. Rao, S-2
Dr. M. Ramakrishnaiah, S-2
Dr. J.B. Rao, S-2

Coimbatore Centre

Shri C. Selvaraj, S-3
Shri V.K. Murugesan, S-2

Pune Centre

Shri P.L.N. Rao, S-2
Shri M.D. Pisolkar, S-2
Shri B.K. Singh, S-1

Raipur Centre

Dr. V.R. Desai, S-3
Shri D. Kumar, S-2
Shri N.P. Srivastava, S-1

Bilaspur Centre

Shri G.K. Bhatnagar, S-3
Dr. K.L. Shah, S-2
Dr. D.K. Kaushal, S-2
Dr. V.K. Sharma, S-1

ESTUARINE DIVISION

Barrackpore Centre

Dr. B.N. Saigal, S-3 (Head)
Shri R.N. Pal, S-3
Shri B.B. Ghosh, S-3
Dr. A.K. Ghosh, S-2
Dr. M.K. Mukhopadhyay, S-2
Dr. H.C. Joshi, S-2
Shri M.M. Bagchi, S-2
Dr. R.K. Das, S-2
Shri P.M. Mitra, S-2
Dr. M.K. Das, S-2
Dr.D.K. De, S-2
Shri H.C. Karmakar, S-2
Shri A. Mukherjee, S-2
Dr. Babulal, S-2

Vadodara Centre

Shri D. Nath, S-2
Dr. S.N. Singh, S-1
Shri S.K. Sarkar, S-1

Calcutta Centre

Shri G.N. Saha, S-3
Shri A.C. Nandy, S-2
Shri S.C. Thakurta, S-2
Dr. R.K. Banerjee, S-2
Shri G.C. Laha, S-1 (under transfer to Vadodara)

Canning Centre

Shri S.N. Dutta, S-2

BRACKISHWATER IMPOUNDMENT SECTION, Barrackpore

Shri ApurbaGhosh, S-3
Dr. Amitabha Ghosh, S-2
Shri P.K. Chakraborty, S-2
Dr. K.R. Naskar, S-2
Shri A. Hazra, S-1

OTHER CENTRES/SECTIONS AT BARRACKPORE

Inland molluscs Section

Shri V.V. Sugunan, S-2
Ms. G.K. Vinci, S-2
Dr. V.K. Unnithan, S-2

Beel Fisheries Section

Dr. K.K. Vass, S-3
Dr. M.J. Bhagat, S-2
Dr.(Ms.) Krishna Mitra, S-2

Extension Section

Shri D.D. Halder, S-3
Shri U. Bhowmick, S-2
Shri J.G. Chatterjee, S-2
Sshri P.K. Pandit, S-2

Engineering Section

Shri A.B. Mukherjee, S-3

Economics Section

Shri S. Paul, S-2

Central Sector Scheme for Inland Fisheries Statistics

Shri R.A. Gupta, S-3
Shri S.K. Mondal, S-2

Scientists on Deputation/Lien

Dr. P.V. Dehadrai, S-5 (Per. Grade), ICAR, New Delhi

Dr. M.Y. Kamal, S-3, ICAR, New Delhi

Dr.P. Das, S-4 (Per. Grade), NBFGR, Allahabad

Dr. Kuldip Kumar, S-2, State Fisheries Dept., Himachal Pradesh

Dr. G.N. Chattopadhyay, S-2, Visva-Bharati, Santiniketan

Shri S.K. Saha, S-2, Planning Commission, Govt. of India, New Delhi.

The following members of staff (Technical/Auxiliary) rendered their services during the year.

Sr. R.A.

Shri S.N. Sar

T-6

Shri J. Ghosh

T-5

Shri Ramchandra
Shri A.K. Roy
Shri Md. F. Rahman
Shri P.S.C. Bose
Shri R.N. De
Shri R.C. Singh
Shri R.C. Satapati
Shri A.R. Mazumder
Ms. Anjali De
Shri P.K. Ghosh
Shri S.K. Das
Shri N.K. Srivastava
Shri K.S. Rao
Shri T.S. Rama Raju

T-4

Shri A.R. Paul
Shri K.S. Banerjee
Shri K.K. Agarwal
Shri D.N. Srivastava
Shri B.D. Saroj
Shri Alok Sarkar
Shri N.N. Mazumdar
Shri S.P. Ghosh
Shri N.C. Mondal
Shri H.K. Sen
Shri P. Dasgupta

T-II-3

Shri J.P. Mishra
Shri H. Chaklader
Shri Amiya Kr. Banerjee
Shri Fatik Manna
Shri Ramji Tiwari
Shri Camil Lakra
Shri M.P. Singh
Shri S.K. Srivastava
Shri D.K. Biswas
Shri T. Chatterjee
Shri Pintu Biswas
Shri B.K. Biswas
Shri H.C. Banik
Ms. Keya Saha
Ms. Arati Das
Ms. K. Sucheta Majumder
Shri B.B. Das

T-I-3

Shri D. Sanfui
Shri S.K. Chatterjee
Shri A.K. Banerjee
Shri R.M. Roy
Shri T.P. Ghosh
Shri Donald Singh
Shri M.M. Das
Shri S.N. Sadhukhan
Shri Swapan Chatterjee
Shri K.P. Singh

T-2

Ms. Rina Basak
Shri D. Chatterjee
Shri B.N. Das
Shri P. Rajani
Shri Bhai Lal
Shri R.K. Halder
Shri A. Mitra

T-1

Shri Prahlad Singh
Shri L.K. Parbat
Shri D. Saha
Shri S. Bandopadhyay
Shri C.G. Rao
Shri S. Kottaiah
Shri Atanu Das
Shri H.L. Biswas
Shri S.N. Chakki
Shri A.K. Barui
Shri Hiralal Biswas
Shri K.K. Das
Shri H.K. Routh
Shri Saradindu Chakraborty
Ms. Shuvra Das
Shri S.K. Chakraborty
Shri N.K. Saha

Auxiliary

Shri P.R. Rao, Hindi Translator
Shri V.G. Dhindore, Driver
Shri Swapan Kr. Das, Time Keeper
Shri G.N. Burman, Mike Operator
Shri S.K. Biswas, Carpenter
Shri S.K. Dev, plumber
Shri A.K. Mazumdar, Driver
Shri D. Bergyoary, Driver
Shri K. Ganesan, Driver
Shri K.L. Chakraborty, Sr. Gestetner Operator
Shri J.L. Bose, Sr. Gestetner Operator
Md. Samud, Mike Operator
Shri S.C. Bhowmick, Sr. Gestetner Operator
Shri S. Bhattacharjee, Carpenter
Shri N.C. Roy, Plumber
Shri K.L. Das, Driver
Shri Kanchan Datta, Driver
Shri U.K. Chatterjee, Driver
Shri R.L. Balmiki, Driver
Shri S. Bahadur, Driver
Shri Badal Lal Singh, Driver
Shri N.C. Biswas, Driver
Shri K.R. Dev, Driver
Shri Kishan Deo, Driver
Shri Ranjit Singh, Driver
Shri M.C. Paul, Driver
Shri C.R. Das, Pumpman

The following members of staff (Administrative) rendered their services during the year.

Senior Administrative Officer

Shri L.M. Nandy

Accounts Officer

Shri J.R. Verma

Administrative Officer

Shri A.C. Ghosh

Assistant Administrative Officer

Shri A.K. Sengupta

P.A. to Director

Shri G. Lahiri

Senior Stenographer

Shri R.C. Srivastava

Superintendent

Shri B.C. Dutta
Shri M.R. Roy
Shri N.K. Sarkar
Shri S.C. Roy

Assistant

Shri N.H. Baidya
Shri B.C. Bhattacharjee
Shri M.M. Neogi
Shri D.C. Bose
Shri I.N. Kodandaraman
Ms. Bani Roy
Ms. Namita Choudhury
Shri S. Dasgupta
Ms. S. Majumder
Shri D.K. Banerjee
Shri S.K. Paramanick
Shri S.P. Sastry
Shri Mahesh Prasad
Shri C.C. Das
Shri R.C.P. Singh

Stenographer

Shri U.K. Ghosh
Shri T.K. Roy
Shri S. Bhattacharjee

Senior Clerk

Shri T.K. Sreedharan
Shri L.P. Mishra
Shri Baij Nath
Shri S.K. Kar
Shri N.K. Mitra
Shri J.C. Patra
Shri Keshab Prasad
Shri H.K. Nath
Shri J.N. Banerjee
Shri S.K. Sarkar
Shri D.N. Baidya
Shri S.R. Halder
Shri H.L. Sarkar
Shri B.B. Mukherjee
Shri B.C. Mazumdar
Shri S. Bhowmick
Shri M.K. Das
Shri D.K. De Sarkar
Shri R.R. Mukherjee
Shri M. Kachhap
Shri A.B. Biswas
Shri S.B. Roy
Shri H.B. Sutar
Shri T.K. Mazumder

Shri Ranjit Kr. Ghosh
Shri Kalu Singh
Shri S.S. Sinha

Junior Stenographer

Ms. G. Vinoda Lakshmi

Junior Clerk

Ms. Sikha Mazumder
Ms. N. Banerjee
Ms. G. Mazumder
Ms. M. Banerjee
Ms. Anita Mazumder
Ms. Bulbul Mandal
Ms. A. Neogi
Ms. A. Chakraborty
Ms.Jayasree Pal
Ms. Swapna Talapatra
Ms. Sefali Biswas
Ms. Shyamali Samanta
Shri S.P. Mondal
Shri K. Majhi
Shri Paras Ram
Shri S.K. Maranappan
Shri Kunja Behari
Shri Chotte Lal
Shri Ambika Lal
Shri Samir Kr. Roy
Shri P.K. Dutta
Shri P. Lahiri
Shri B.K. Das
Shri S.K. Bose
Shri N.R. Kundu
Shri J. Roy
Shri Biswanath Sah
Shri S.K. Tikadar
Shri U. Bhattacharjee
Shri P.K. Ghosh
Md. Quasim
Shri Surendrea Kumar
Shri C.K. Pandey
Shri C.K.N. Sahi
Shri K.S. Rao
Shri M.L. Biswas
Shri Debesh Chowdhury
Shri Brahmapal Balmiki
Shri S. Karmakar
Shri Sukumar Sarkar
Shri A.K. Dey
Shri M.K. Joardar
Shri S.K. Ghosh

The following members of staff of supporting grade rendered their services during the period.

Supporting Grade IV

Shri R.L. Raikwar
Shri J.M. Kujur
Shri H.B. Lama
Shri Antiram Das
Shri H.K. Das
Shri J.N. Biswas
Shri T.K. Biswas
Shri Sunil Kr. Das
Shri M.S. Burman
Shri M.C. Raikwar
Shri Mewa Lal
Shri H.K. Pramanick
Shri Nar Bahadur (Ad-hoc)

Supporting Grade III

Shri S.C. Balmiki
Shri P. Sayalu
Shri S.P. Yadav

Shri B.N. Mondal
Shri R.N. Tar
Shri Laluram Balmiki
Shri A.M. Patra
Shri B.B. Das
Shri Balaram Bhanja
Shri S.N. Burman
Shri S.K. Burman
Shri G.C. Mondal
Shri C.K. Vava (Ad-hoc)
Shri D.D. Poudel
Shri Budh Prakash
Shri Jungli
Shri Jugal Kishsore
Shri S.K. Boral
Shri Tek Bahadur
Shri Sitaram Balmiki
Shri H.S. Burman
Shri S.S. Burman
Shri Munshi Ram Balmiki
Shri L. Samulu
Shri Bhim Bahadur (Ad-hoc)
Shri K.L. Bakmiki

Supporting Grade II

Shri Munnilal Mallah
Shri Maha Singh
Shri Dukhharan Sahani
Shri Laxmi Ram
Shri Suraj Bahadur
Shri B.N. Mondal
Shri Joseph Khalko
Shri Rajendra Ram
Shri A. Sahani
Shri C.P. Singh
Shri K.D. Raju
Shri P. Seshanna
Shri P.C. Bez
Shri D.C. Das
Shri B.C. Das
Shri B. Hazarika
Shri P.C. Kachari
Shri A.L. Yadav
Shri Parameswar
Shri Nikunja Lal Das
Shri H.K. Burman
Shri A.K. Biswas
Shri Khimchand Balmiki
Shri S.G. Biswas
Shri L.K. Halder
Shri A.C. Ghosh
Shri J.N. Mallah
Shri Gulab Shaw
Shri Subrahmani
Shri M. Mahadeva
Shri K. Ningigowda
Shri S.T. Gavate
Shri S. Mahendran (Ad-hoc)
Shri V. Mariappan
Shri A. Ramaswamy
Shri M.V. Krishnan
Shri K. Kalianan
Shri Ram Prasad
Shri Karam Raj
Shri Satyendra Burman
Shri Lalta Prasad
Shri Sita
Shri Rajdhari Mallah
Shri Sukchand Biswas
Shri Bideshi Lal
Shri Ram Sunder
Shri B. Pugalendhi
Shri Om Prakash
Shri M.P. Bind
Shri A. Gangaiah
Shri K. Bahadur (Ad-hoc)
Shri A. Biswas
Shri R. Palaneswami
Shri A. Murugeshan

Supporting Grade I

Shri Lakshmi Ram
Md. Yusuf Dar
Shri Suresh Kumar
Shri Umesh Chowdhury
Shri Kuldeep Singh
Ms. Bimla Devi

Shri Kawalpati Ram
Shri Mahadev Panika
Shri S. Rajak
Shri R.U. Muchi
Shri Suresh Rajak
Shri A. Kistaiah
Shri U. Satyanarayana
Shri S. Jaan
Shri P. Atchaiah
Shri S. Kalita
Shri N. Deka
Shri Khagen Ch. Das
Shri Bhabalu Boro
Shri Jai Ram Prasad
Shri J. Mukhiya
Ms. Mina Biswas
Ms. B. Balmiki
Shri K.C. Malakar
Shri K.K. Dhir
Ms. Godhuli Mondal
Shri H.P. Bhanji
Shri T. Ghosh
Shri Sankar Bose
Ms. Mina Rani Bahadur
Shri Muktipada Das
Shri Kharban Kumar
Shri Man Bahadur
Shri S.L. Bairagi
Shri Bhaskar Sardar
Shri Pasupati Ghosh
Shri Jagdish Balmiki
Shri S. Banerjee
Shri Sibu Lal Das
Shri S.C. Sadhukhan
Shri Dipak Chakrabsorty
Shri Biswanath Bose
Shri Ananta Kr. Bhanja
Shri Rabi Kr. Sardar
Shri Lal Bahadur
Shri Dilip Kr. Das
Ms. B. Sakuntala
Shri Mohan Lal Sarkar
Ms. Hemlata Halder
Shri Balkishen Balmiki
Shri S.N. Nan
Shri Mahendra Balmiki
Shri Ullas Naik
Ms. Rupali Chatterjee
Shri Ashok Kr. Dey
Shri Mohan Lal Saha
Shri Ganesh Ch. Paramanick
Shri Iswarram Balmiki
Shri C.P. Singh
Ms. Anjali Dutta
Shri Bharat Kr. Halder
Shri Anil Ch. Das
Shri S. Guin
Shri P. Singh
Shri D. Singh
Shri Atiullah
Shri Sitla Prasad
Ms. Kamal Devi
Shri M. Anjanappa
Shri B.N. Krishnappa
Shri S.S. Bondre
Shri G. J. Roundale
Shri M.S. Bhoi
Shri T.H. Ghume
Shri K. Subbaiya
Shri R. Nagraj
Shri S. Govindarajan
Shri K. Subramahnaiyan
Shri Gopal Chand
Ms. Kalosasi Mondal
Shri G. Lal
Shri Sree Nath
Shri A.C. Biswas
Shri R.D. Chaudhury
SK. Monsur Ali
Shri S.K. Chakraborty
Shri Gunadhar Dhibar
Shri Prasidh Sahani
Shri Amar Nath Prasad
Shri Umashankar Ram
Shri P.C. Pramanick
Shri Prakash Ch. Paramanick
Shri N.K. Das
Shri Joydev Patra
Shri A. Bhattacharjee
Shri K. Kumar
Ms. Dharamaiya
Shri M. Dutta

PROMOTION

On recommendation of the Agricultural Scientists Recruitment Board the following Scientists of this Institute were promoted as shown below :

Name	Designation	Promoted to	With effect from
Dr. R.S. Panwar	S-2	S-3	1.1.1985
Shri A.B. Mukherjee	S-2	S-3	1.1.1985
Dr. Babu Lal	S-1	S-2	1.7.1982
Dr.(Ms.) Krishna Mitra	S-1	S-2	1.1.1985
Dr. B.C. Jha	S-1	S-2	1.1.1985
Dr. V. Pathak	S-1	S-2	1.1.1985
Shri H.C. Karmakar	S-1	S-2	1.1.1985
Dr. K. Chandra	S-1	S-2	1.1.1985
Shri R.K. Tyagi	S-1	S-2	1.1.1985
Shri S.K. Mondal	S-1	S-2	1.7.1985
Shri R.K. Dwivedi	S-1	S-2	1.1.1985
Shri S.N. Singh	S-1	S-2	1.1.1985
Dr. M.J. Bhagat	S-1	S-2	1.1.1985

The following memabers of staff were promoted on recommendation of the Assessment Committee/Departmental Promotion Committee during the period.

Name	Designation	Promoted to	With effect from
Shri A.K. Roy	T-4	T-5	1.1.1988
Md. F. Rahman	T-4	T-5	1.1.1988
Shri Ramchandra	T-4	T-5	1.1.1988
Shri P.S.C. Bose	T-4	T-5	10.1.1989
Shri J.P. Misra	T-1-3	T-II-3	10.1.1989
Shri B.B. Das	T-1-3	T-II-3	10.1.1989
Shri D. Sanfui	T-2	T-I-3	1..1.1988
Shri B.N. Das	T-1	T-2	10.1.1089

Shri G.N. Burman	T-1	T-2	1.1.1988
Shri K.L. Chakraborty	T-1	T-2	1.1.1988
Shri J.L. Bose	T-1	T-2	1.1.1988
Md. Shamood	T-1	T-2	1.1.1988
Shri Prahlad Singh	SSG-III	T-1	16.2.1989
Shri M.S. Burman	SSG-III	SSG-IV	7.10.1988
Shri Nar Bahadur	SSG-III	SSG-IV(ad-hoc)	2.3.1989
Shri Bhim Bahadur	SSG-II	SSG-III(ad-hoc)	2.3.1989
Shri C.K. Vava	SSG-II	SSG-III(ad-hoc)	2.3.1989
Shri H.S. Burman	SSG-II	SSG-III	7.10.1988
Shri I. Samalu	SSG-II	SSG-III	2.3.1989
Shri S.S. Burman	SSG-II	SSG-III	7.10.1988
Shri Munshi Ram	SSG-II	SSG-III	7.10.1988
Shri K.L. Balmiki	SSG-II	SSG-III	2.3.1989
Shri P.C. Kachari	SSG-I	SSG-II	7.10.1988
Shri M. Murugesan	SSG-I	SSG-II	7.10.1988
Shri R. Palaniswamy	SSG-I	SSG-II	7.10.1988
Shri A. Biswas	SSG-I	SSG-II	7.10.1988
Shri D.C. Das	SSG-I	SSG-II	7.10.1988
Shri P.C. Bose	SSG-I	SSG-II	7.10.1988
Shri B. Pugalendi	SSG-I	SSG-II	2.3.1989
Shri V. Mariappan	SSG-I	SSG-II	2.3.1989
Shri A. Gangayya	SSG-I	SSG-II	2.3.1989
Shri M.P. Bind	SSG-I	SSG-II	2.3.1989
Shri Karna Bahadur	SSG-I	SSG-II(ad-hoc)	2.3.1989
Shri S. Mahindra	SSG-I	SSG-II(ad-hoc)	2.3.1989
Shri S. Bhattacharyya	Jr.Stenographer	Stenographer	30.3.1988
Shri Samir Roy	Junior Clerk	Senior Clerk	2.3.1989
Shri S.B. Roy	Junior Clerk	Senior Clerk(ad-hoc)	12.4.1988

The following members were granted advance increments as below on the recommendation of the Assessment Committee.

Name	Dessignation	Adv. increments	With effect from
Shri D.D. Halder	S-3	3	1.1.1985
Shri P.K. Sukumaran	S-1	2	1.1.1985
Shri A.R. Chowdhary	S-1	2	1.1.1985
Shri S.K. Sarkar	S-1	2	1.1.1985
Shri A.R. Majumdar	T-5	3	1.1.1988
Shri T.S. Rama Raju	T-5	3	1.1.1988
Shri K.S. Rao	T-5	2	1.1.1988
Shri R.C. Singh	T-5	1	1.1.1988
Shri R.N. De	T-5	1	1.1.1988

Shri K.K. Agarwal	T-4	1	1.1.1988
Shri P.S.C. Bose	T-4	2	1.1.1988
Shri R.M. Roy	T-I-3	2	1.1.1988
Shri Kishan Deo	T-I-3	1	1.1.1988
Shri S. Bhattacharjee	T-I-3	1	1.1.1988
Shri S.N. Sadhukhan	T-I-3	1	1.1.1988
Shri Swapan Chatterjee	T-1-3	1	1.1.1988
Shri Donald Singh	T-I-3	3	1.1.1988

Retirement during the period

Name	Designation	Date of Retirement
Shri B.V. Govind	S-3	31.12.1988
Shri N.C. Basu	T-7	31.12.1988
Shri K.B. Rajani	Administrative Officer	31.3.1988
Md. Sahmood	T-1	30.11.1988
Shri H.B. Lama	SSG-IV	31.3.1989
Shri P.V. Varghese	SSG-IV	31.8.1988
Shri Chattar Singh	SSG-III	30.6.1988

Resignation

Name	Designation	Date of acceptance
Shri Arup Chatterjee	Assistant	30.4.1988
Shri N.K. Azad	T-II-3	31.7.1988

Appointments

Following appointments were made during the period

Name	Designation	Place of posting	Date of appointment
Shri K.R. Verma	Accounts Officer	Barrackpore	1.1.1988
Shri A.C. Ghosh	Adm. Officer	Barrackpore	2.5.1988
Md. Quasim	Junior Clerk	Barrackpore	17.10.1988
Shri P. Das Gupta	T-4 (ad-hoc)	Barrackpore	1.9.1987
Shri N.K. Azad	T-II-3	Barrackpore	11.4.1988
Ms. Arati Das	T-II-3	Barrackpore	7.4.1988
Ms. K. Sucheta Mazumdar	T-II-3	Barrackpore	30.11.1988
Shri D. Chatterjee	T-2	Barrackpore	10.3.1988
Ms. Rina Basak	T-2	Barrackpore	22.3.1988
Shri Arunava Mitra	T-2	Barrackpore	21.3.1988
Shri P. Rajani	T-2	Bangalore	28.4.1988
Shri Atanu Das	T-1	Barrackpore	21.3.1988
Shri S.N. Chaki	T-1	Barrackpore	10.3.1988
Shri Saradindu Chakraborty	T-1	Barrackpore	10.3.1988
Shri Hiralal Biswas	T-1	Barrackpore	10.3.1988
Ms. Shuvra Das	T-1	Barrackpore	18.3.1988
Shri S. Bandyopadhyay	T-1	Agra	14.12.1988
Shri Debassis Saha	T-1	Pune	21.12.1988
Shri K.K. Das	T-1 (ad-hoc)	Barrackpore	10.3.1988
Shri H.K. Routh	T-1 (ad-hoc)	Barrackpore	10.3.1988
Shri A.K. Barui	T-1 (ad-hoc)	Barrackpore	10.3.1988
Shri V.G. Dhindore	Driver	Pune	16.8.1988
Shri S. Kalita	SSG-I	Guwahati	16.4.1988
Shri R. Nagaraj	SSG-I	Coimbatore	14.4.1988
Shri Suresh Kumar	SSG-I	Agra	1.11.1988
Shri A.N. Prasad	SSG-I	Vadodara	7.11.1988
Shri Uma Shankar Ram	SSG-I	Vadodara	7.11.1988
Shri P. Sahani	SSG-I	Vadodara	3.11.1988
Shri P.C. Paramanick	SSG-I	Canning	16.11.1988

Transfers

The following members of CICFRI were transferred during the period April 1988 to March 1989.

Name	Designation	From	To
Dr. K.K. Vass	S-3	Srinagar	Barrackpore
Shri C. Selvaraj	S-3	Pollachi	Coimbatore
Shri V.K. Murugesan	S-2	Pollachi	Coimbatore
Dr. K.L. Shah	S-2	Karnal	Bilaspur
Dr. D.N. Misra	S-2	Karnal	Agra
Dr. Krishna Chandra	S-2	Allahabad	Agra
Dr. (Ms.) U. Moza	S-2	Srinagar	Agra
Dr. H.P. Singh	S-2	Bilaspur	Allahabad
Shri Dhirendra Kumar	S-2	Patna	Raipur
Shri K.P. Srivastava	S-2	Muzaffarpur	Patna
Dr. A.K. Laal	S-2	Bhagalpur	Bangalore
Shri S.K. Wishard	S-2	Agra	Allahabad
Dr. D. Nath	S-2	Canning	Vadodara
Shri V. Kolekar	S-1	Pune	Agra
Shri S.K. Sarkar	S-1	Bhagalpur	Vadodara
Dr. B.C. Jha	S-1	Muzaffarpur	Patna
Dr. S.N. Singh	S-1	Muzaffarpur	Vadodara
Shri R.C. Singh (T.N.)	T-5	Patna	Aliyarnagar
Shri K.S. Banerjee	T-4	Allahabad	Vadodara
Shri D.K. Biswas	T-II-3	Bhagalpur	Guwahati
Shri Ramji Tiwari	T-II-3	Bhagalpur	Agra
Shri Camil Lakra	T-II-3	Muzaffarpur	Patna
Shri Kallu Singh	Senior Clerk	Allahabad	Agra
Shri T.K. Sreedharan	Senior Clerk	Pollachi	Coimbatore
Shri Surendra Kumar	Senior Clerk	Raipur	Bhagalpur
Shri Paras Ram	Junior Clerk	Bhagalpur	Bilaspur
Shri K. Manjhi	Junior Clerk	Bilaspur	Raipur
Shri S.K. Maranappan	Junior Clerk	Pollachi	Coimbatore
Shri S.P. Mondal	Junior Clerk	Barrackpore	Calcutta
Shri Krishan Deo	Driver	Muzaffarpur	Allahabad
Shri R.N. Tiar	SSG-III	Bhagalpur	Patna
Shri A.L. Yadav	SSG-II	Bhagalpur	Patna
Shri S.C. Balmiki	SSG-II	Karnal	Agra
Shri Gulab Shaw	SSG-II	Allahabad	Raipur
Shri H.B. Lama	SSG-II	Muzaffarpur	Patna

Shri Suraj Bahadur	SSG-II	Muzaffarpur	Patna
Shri Lakshmi Ram	SSG-II	Muzaffarpur	Patna
Shri Dukharan Saheni	SSG-II	Muzaffarpur	Patna
Shri Bholanath Mondal	SSG-II	Muzaffarpur	Patna
Shri C.K. Vava	SSG-II	Pollachi	Coimbatore
Shri K. Subramanium	SSG-I	Pollachi	Coimbatore
Shri S. Govindarajan	SSG-I	Pollachi	Coimbatore
Shri R. Nagaraju	SSG-I	Pollachi	Coimbatore
Md. Yusuf Dar	SSG-I	Srinagar	Agra
Shri B. Pugalendi	SSG-I	Pulicat	Coimbatore
Shri Lakshi Ram	SSG-1	Karnal	Agra
Shri Kawalpati Ram	SSG-I	Muzaffarpur	Patna
Shri Mahadev Panikar	SSG-I	Muzaffarpur	Patna
Shri N. Rajak	SSG-I	Muzaffarpur	Patna
Shri Ram Deo Chowdhury	SSG-I	Bachhra	Allahabad
Shri Mahadev Panikar	SSG-I	Patna	Raipur

The following members of the Institute were relieved from the Institute to take up new assignment to other organisations during the period.

Name	Designation	Relieved on	To join at
Shri R.M. Rao Kausalyagang	S-2	15.3.1988	CIFA,
Shri Ram Deo Singh	Junior Clerk	11.4.1988	-do-
Shri D.P. Verma	T-I-3	8.1.1988	-do-
Shri M.B. Naik	SSG-II	7.7.1988 (AN)	Directorate of Oil Seed Research, Rajendra Nagar, Hyderabad
Dr. G.N. Chattopadhyay	S-2	7.1.1988	Visva-Bharati, Santiniketan

वार्षिक रिपोर्ट 1988–89

केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान
(भा.कृ.अनु.प.) : बैरकपुर : पश्चिम बंगाल

संक्षिप्त इतिहास

भारत सरकार ने सन् 1943 में अपने एक ज्ञापन में देश के मात्स्यकी स्त्रोतों के विकास हेतु एक केन्द्रीय विभाग की स्थापना पर विशेष बल दिया था। तत्पश्चात् कृषि, वानिकी तथा मात्स्यकी से संबंधित केन्द्रीय सरकार नीति-समिति की मात्स्यकी उप-समिति ने इस विषय का पृष्ठांकन किया था। इसके आधार पर 17 मार्च सन् 1947 में भारत सरकार के खाद्य तथा कृषि मंत्रालय के अधीन कलकत्ता में केन्द्रीय अंतर्स्थलीय मात्स्यकी अनुसंधान केन्द्र की स्थापना औपचारिक रूप में हुई। एक अन्तरिम योजना के रूप में प्रवर्तित यह अब अंतर्स्थलीय मात्स्यकी क्षेत्र में एक प्रमुख अनुसंधान संस्थान बन गया। यह केन्द्र सन् 1959 में एक अनुसंधान संस्थान का पूर्ण रूप ग्रहण कर बैरकपुर स्थित अपने निजी भवन में स्थानान्तरित हो गया। सन् 1967 से यह संस्थान भारतीय कृषि अनुसंधान परिषद (आई.सी.ए.आर.) के प्रशासनिक प्रबंध में है। इस संस्थान का मुख्य उद्देश्य देश के मात्स्यकी स्त्रोतों के उचित मूल्यांकन हेतु अन्वेषण करना तथा इनके संरक्षण और समुचित उपयोग के लिए उपयुक्त पद्धतियों को विकसित करना है। उक्त उद्देष्यों की पूर्ति के दौरान यह संस्थान अपने अनुसंधानात्मक प्रयासों द्वारा विभिन्न प्रकार के जल-स्त्रोत जैसेः नदी, सरोवर, तालाब, जलाशय और चापझील के पर्यावरण तथा उत्पादन-क्रियाशीलताओं को सुलझाने का प्रयत्न कर रहा है। इन अध्ययनों द्वारा भिन्न-भिन्न प्रकार के वातावरण में जलीय-पारिस्थितिक तंत्र की जटिल पोषी संरचना तथा प्रकार्यों को सुलझाया गया है। संस्थान के अधिदेश में किंचित परिवर्तन कर देश के प्रग्रहण मात्स्यकी स्त्रोतों पर विशेष ध्यान दिया

गया तथा 1.4.87 से संस्थान का नामकरण केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान किया गया। पुनर्प्रतिष्ठित के.अ.प्र.मा.अनु.स. को उन उन्मुक्त जल क्षेत्रों में अनुसंधान कार्य करने का दायित्व सौंपा गया है जहां मात्स्यकी प्रबंध प्रणाली पर्यावरणीय अनुकूलन तथा संरक्षण से सम्बद्ध है।

अधिदेश

प्राकृतिक एवं मनुष्य द्वारा निर्मित अंतर्स्थलीय जल-स्त्रोतों में संग्रहण, उचित समुपयोजन एवं संरक्षण द्वारा मछली उत्पादन में वृद्धि के लिए अनुसंधान करने हेतु इस संस्थान की स्थापना की गई है।

संगठन

उक्त उद्देष्यों की प्रप्ति हेतु संस्थान के अनुसंधान कार्य को देश के मुख्य मात्स्यकी स्त्रोतों के अनुरूप तीन प्रभागों के अन्तर्गत रखा गया है। नदीय प्रभाग अपने इलाहाबाद स्थित मुख्यालय से देश के नदीय मात्स्यकी स्त्रोतों की सम-प्रबंध पद्धतियों को विकसित करने के लिए, नदीय-पर्यावरण के संरक्षण में आवश्यक ध्यान देते हुए कार्य कर रहा है। गंगा, यमुना, ब्रह्मपुत्र और नर्मदा नदियाँ इस प्रभाग की मुख्य अनुसंधान परियोजना के अंतर्गत आती हैं। सरोवरीय प्रभाग का मुख्यालय बैंगलूर में तथा इसके केन्द्र तमिलनाडु, आन्ध्र प्रदेश, उत्तर प्रदेश, मध्य प्रदेश, हिमाचल प्रदेश और महाराष्ट्र में स्थित है। इसके अन्वेषणों का लक्ष्य बडे तालाबों, सरोवरों और जलाशयों में मत्स्य उत्पादन बढ़ाने हेतु, प्रबंध पद्धतियों को विकसित करना है। बैरकपुर स्थित ज्वास्नदमुखी प्रभाग पूरे हुगली-मातलाह ज्वारनदमुखी तंत्र और नर्मदा ज्वारनदमुखी क्षेत्र में विभिन्न अनुसंधान योजनाओं का संचालन कर रहा है। अनेक औद्योगिक केन्द्रों के बहिस्त्राव तथा कृषीय और नगरपालिका के अपरद्द पदार्थों के प्रवाह के कारण हुगली ज्वारनदमुखी क्षेत्र को गंगा नदीय तंत्र के अत्यधिक प्रदूषित क्षेत्रों में एक माना जा रहा है। इस प्रदूषित क्षेत्र पर यह प्रभाग कार्य

कर रहा है। ज्वारनदमुखी मछलियों में महत्वपूर्ण मछली हिलसा पर गहन अनुसंधान कार्य चल रहा है। यह संस्थान प॰ बंगाल और आसाम की बीलों और गन्डक बेसिन की चापझीलों ('मन') पर भी अनुसंधानात्मक कार्य कर रहा है। इनके अतिरिक्त विवृत जल क्षेत्रों में केज तथा पेन कलचर, अंतर्स्थलीय धोंधों की पारिस्थितिकी एवं उत्पादन प्रक्रिया, हाइड्रॉलिक संरचनाओं से मत्स्य पारगमन के अभियांत्रिक पहलुओं तथा मात्स्यकी के आर्थिक और सांख्यिक विषयों पर भी अनुसंधान कार्य हो रहा है। इस संस्थान के अनुसंधान कार्य को 20 अनुसंधान परियोजनाओं तथा एक केन्द्रीय सेक्टर योजना में विभाजित किया गया है।

मुख्य उपलब्धियां

छोटे जलाशयों का सफल प्रबंध

छोटे जलाशयों की कालगत पोषक गुणवत्ता पर आधारित संग्रहण नीति इनकी मत्स्य उपज को बढाने में एक उपयोगी उपादान सिद्ध हुई है। यह प्रबंध नीति इलाहाबाद के पास स्थित सिंचाई के लिए बने बछरा जलाशय (140 हे॰) के मामले में काफी लाभकारी सिद्ध हुई है। इस वर्ष अभी तक का सर्वाधिक उत्पादन (140 कि॰ग्रा॰/है॰) इस नीति की सफलता का स्पष्ट संकेत देता है। संग्रहण से मेजर कार्प उपजातियों के यथोचित संयोजन द्वारा मत्स्य उत्पादन में उनके योगदान को बढ़ाने में काफ़ी सहायता मिली है।

इस अनुभव के आधार पर यह निर्धारित किया गया है कि भविष्य में उक्त प्रकार के पारिस्थितिक तंत्रों में मत्स्य विकास हेतु उनकी सम्भाव्य उपज के निर्धारण तथा वातावरण में उपलब्ध पारिस्थितिक गुणों के आधार पर ही संग्रहण नीति का प्रतिपादन किया जाए। प्रायद्वीपीय भारत के छोटे जलाशयों में भी इस प्रबंध प्रणाली की उपादेयता का सफल परीक्षण किया गया है। तमिलनाडु के अलियार जलाशय में 170 कि॰ग्रा॰/हे॰ उपज की प्राप्ति हुई है। सातवीं योजना के अंत तक उपज की दर 150 कि॰ग्रा॰/हे॰ होने की संभावना है।

मछलियों में व्रणकारी रोग संलक्षण

असम, त्रिपुरा और मेघालय की नदियों, नहरों, जलाशयों, झीलों, धान के खेतों तथा तालाबों की मछलियों में व्रणकारी रोग संलक्षण का जानलेवा रूप धारण करना आम जनता और मत्स्य वैज्ञानिकों के लिए एक गम्भीर विषय बन गया है। भारत में मछलियों के किसी रोग के इतने व्यापक रूप में फैलने की यह पहली घटना है। यह रोग सन् 1972 से एशिया-पैसफ़िक क्षेत्र में गम्भीर समस्या बना हुआ है। भारत में केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान इस रोग का अवलोकन कर रहा है। इस संस्थान ने अप्रैल 1988 में देश के विभिन्न राज्यों को इस रोग के प्रति सचेत किया था और मई महीने में यह भविष्यवाणी सच निकली। केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान द्वारा किए गए अन्वेषणों से निम्नलिखित उल्लेखनीय विषयों की जानकारी मिलती है :-

क) असम के चाचर जिले के जलालपुर और हइलाकन्दी उप-मंडल, त्रिपुरा के पश्चिमी और दक्षिणी जिले, मेघालय के पूर्व खासी पहाडी तथा गारो पहाडी जिले प्रभावित क्षेत्र हैं। इन ज़िलों के बंगलादेश के सीमावर्ती क्षेत्रों में रोग की तीव्रता अत्यधिक है।

ख) रोग-ग्रसित मछलियां विशेषकर नदियों, नहरों, बीलों, धान के खेतों और कुछ मात्रा में अप्लावित तालाबों में पाई गई थीं। इस रोग की व्यापकता उस क्षेत्र तक थी जहां तक रोग-ग्रसित मछलियां बाढ के जल द्वारा पहुंच गई थीं।

ग) मरेल, शिंगटी और कार्प की अनेक जातियों पर इसका प्रभाव पडा, जिनमें से *चाना स्ट्रायटस, सी॰ पंक्टेटस, सी॰ बैट्रेकस, मैस्टोसेम्बेलस पेन्केलस, एम॰ आर्मेटस, साइप्रिनस कार्पियो, पुन्टियस सोफ़ोर, एम्ब्लीफ़ैरिंगेडौन मोला, मिस्टस विटेटस* और *एक्रोसोकाइलस हेक्जागोनोलेपिस* उपजातियों पर अत्यधिक दुष्प्रभाव पडा।

घ) प्रभावित जल क्षेत्र में प्रायः निम्न क्षारीयता और कठोरता, अम्लीय गुणवत्ता तथा मृदा में कैल्सियम की कमी देखी गई है।

ङ) बंगलादेश के बाढ जल से प्रवाहित रोग-ग्रसित मछलियों द्वारा रोग का निर्गमन हुआ हैं, जहां इस रोग का प्रादुर्भाव फरवरी/मार्च 1988 में हुआ था।

च) रोग व्याप्त होने के कारण मछलियों की खरीद अचानक गिरने लगी। केन्द्रीय

अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान द्वारा इसकी रोकथाम के लिए छोटे प्रबंध योग्य जल क्षेत्रों में चूना तथा सोडियम क्लोराइड (नमक) के उपयोग का सुझाव दिया गया। प्रभावित राज्यों के मत्स्य अधिकारीगण इन उपचारी सुझावों का कार्यान्वयन कर रहे हैं। नेटवर्क ऑफ एक्वाकल्चर सेन्टर्स इन एशिया द्वारा प्रवर्तित एक अंतर्राष्ट्रीय परियोजना के अंतर्गत भारत-स्थित केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान, बैरकपुर सहित ग्यारह देशों में इस रोग पर शोध कार्य चल रहा है।

गंगा नदीय तंत्र में हिलसा की जीव संख्या का अध्ययन

गंगा नदीय तंत्र तथा बंगाल की खाडी के हुगली ज्वारनदमुखी नदीय क्षेत्रों में बसने वाली हिलसा मछलियों की विभिन्न प्रजातियों या उप-समष्टियों की मौजूदगी का पता लगाने के लिए भागीरथ-हुगली ज्वारनदमुखी तथा गंगा-पद्मा क्षेत्र से लिए गए नमूनों का प्रजातीय अध्ययन किया गया है। एलेक्ट्रोफोरेटिक पद्धति के द्वारा रूधिर सीरम प्रोटीन की एमिनो एसिड पट्टियों के घनत्व तथा उनकी वितरण पद्धति का अध्ययन हिलसा की दो पृथक उप-समष्टियों के अस्तित्व का स्पष्ट संकेत देता है। यह अध्ययन फ़रक्का बांध के ऊपरी भाग से प्रवर्जित मछलियों को पहचानने तथा गंगा नदीय तंत्र के ऊपरी क्षेत्रों में हिलसा मात्स्यकी के विकास हेतु उपयुक्त संरक्षण और प्रबंध प्रणालियों को अपनाने में सहायक सिद्ध होगा।

नदीय पारिस्थितिक तंत्र की ऊर्जा गतिकी

गंगा और यमुना नदी के विभिन्न क्षेत्रों में किए गए सरो-वैज्ञानिक अन्वेषणों से प्राथमिक उत्पादक स्तर पर आपतित सौर ऊर्जा के रासायनिक ऊर्जा में रूपान्तरण में उल्लेखनीय विभिन्नता देखी गई है। प्रकाश-संश्लेषी जीवों द्वारा सौर ऊजा का स्थिरीकरण इलाहाबाद में 0.06–1.10% तथा पटना में 0.083 से 0.53% की तुलना में कानपुर में 0.02–0.27% पाया गया है। प्राथमिक उत्पादक स्तर पर संचित ऊर्जा के आधार पर कानपुर, इलाहाबाद और पटना में प्रतिवर्ष क्रमशः 74, 249 तथा 292 कि॰ग्रा॰/हे॰ मत्स्य उत्पादन क्षमता का अनुमान लगाया गया है। इसी प्रकार के अध्ययन इलाहाबाद के पास यमुना नदी के दो अन्य क्षेत्रों में भी किए गए हैं जहां सूर्य किरणों से प्राथमिक उत्पादकों में ऊर्जा

रूपान्तरण 0.025 से 0.480% तक है । इलाहाबाद के समीप यमुना नदी में प्रतिवर्ष 107 कि॰ग्रा॰/हे॰ संग्रहण योग्य मत्स्य उपज का आकलन किया गया है । इस अध्ययन से स्पष्ट होता है कि प्राकृतिक वास में मानवोद्भवी परिवर्तनों ने जैव उत्पादन प्रक्रिया तथा प्राथमिक उत्पादकता को क्षीण किया है जिससे मत्स्य उपज में कमी आई है ।

सहयोग

इस संस्थान ने वर्ष 1988–89 के दौरान अनेक राष्ट्रीय तथा अंतर्राष्ट्रीय सहयोगिक अनुसंधान कार्यों में भाग लिया ।

राष्ट्रीय

'अलियार बेसिन के छोटे जलाशयों के मात्स्यकी तथा पारिस्थितिकी' परियोजना के कार्य में केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान को तमिलनाडु सरकार ने फार्म तथा वाहन सुविधाएं उपलब्ध कराकर अपना सक्रिय सहयोग प्रदान किया ।

इसके अतिरिक्त केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान ने विभिन्न अभिकरणों को उनके मात्स्यकी विकास कार्यों में अपनी परामर्शक सेवाओं द्वारा सहयोग दिया ।

केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान द्वारा उपलब्ध की गई परामर्शक सेवाएं :–

1. केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान को कृषीय वित्त

निगम ने उत्तर-पूर्वी राज्यों के लिए एक व्यापक मत्स्य विकास योजना बनाने हेतु परामर्शक के रूप में नियुक्त किया। इस परियोजना में सातों उत्तर-पूर्वी राज्य तथा केन्द्र शासित प्रदेश जैसे असम, मेघालय, मीज़ोरम, नागालैंड, मनीपुर, त्रिपुरा और अरूणाचल सम्मिलित हैं। यह परियोजना इन क्षेत्रों में उपलब्ध विस्तृत मात्स्यकी स्त्रोतों जैसे नदी, चापझील, प्राकृतिक झील, जलाशय, उपरिभूमि झील, पर्वतधारा आदि के विकास हेतु है। एकीकृत उत्पादन पद्धति के अंतर्गत धान-व-मत्स्यपालन की सम्भावनाओं पर भी विचार किया जा रहा है।

2. कन्सल्टिंग सर्विसेज़ इंडिया प्राइवेट लिमिटेड ने पाराद्वीप बन्दरगाह में मौजूदा लोह-अयस्क व्यापार सुविधाओं की विस्तार योजना के अंतर्गत इस क्षेत्र के पर्यावरणीय प्रभाव के मूल्यांकन हेतु इस संस्थान की परामर्शक सेवाओं का उपयोग किया। इस अध्ययन के अंतर्गत भौतिक, रासायनिक और जैविक प्राचलों को, विशेषकर सार्वजनिक क्षेत्रों से समुद्रीय पारिस्थितिकी में प्रवाहित पदार्थ, जैसेः - नगरपालिकाओं से प्रवाहित अपरद्द पदार्थ, भारी धातुएं, हैलोजेनीकृत हाइड्रोकार्बन पदार्थ और शैल-रसायनिक पदार्थों के पूर्ण विवरणों का परिशीलन समावेश किया गया है। इस अध्ययन में समुद्रीय और ज्वारनदमुखी पारिस्थितिकी के वनस्पति तथा प्राणीजातों की सूक्ष्म-जैविक सक्रियता और प्लवक सम्बन्धी आंकड़े भी समावेश किए गए हैं।

3. इसी प्रकार हज़ारीबाग के निकट *नार्थ करणकुला सुपर थरमल पावर प्रोजेक्ट* के पर्यावरण प्रभाव का भी मूल्यांकन किया गया है। एक परामर्शक सेवा के अंतर्गत प्रस्तावित पावर प्लांट के संदर्भ में उस क्षेत्र की जलीय पारिस्थितिकी की रिपोर्ट प्रस्तुत की गई है।

अंतर्राष्ट्रीय

केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान, नेटवर्क ऑफ एक्वाकल्चर सेन्टर्स इन एशिया (नाका) को उनके क्षेत्रीय अनुसंधान परियोजना 'पर्यावरण नियंत्रण और मछलियों में व्रणकारी संलक्षण' में सक्रिय सहयोग दे रहा है। इस परियोजना में अन्य 11 देशों के साथ भारत स्थित केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान, बैरकपुर भी शामिल है। परियोजना का मुख्य उद्देश्य मछलियों में व्रणकारी रोग संलक्षण तथा

पर्यावरण में संबंध स्थापित करना है। तकनीकी कार्यक्रम के अंतर्गत वर्ष 1988-89 के दौरान हर पखवारे में वर्षा और सिंचाई पर आधारित धान के खेतों वाले क्षेत्र की दो कृत्रिम झीलों में भौतिक-रासायनिक प्राचलों तथा भारी धातुओं एवं कीटनाशकों का विश्लेषण, मत्स्य जीवसंख्या (समिष्टि) का नियंत्रण तथा रूधिर विज्ञान सम्बन्धी अध्ययन किया जा रहा है।

इस परियोजना से संबंधित रिपोर्टों को ने.ए.से.ए. (नाका) द्वारा आयोजित 'व्रणकारी मत्स्य रोग और पर्यावरण' पर 20-24 मार्च 1988 में थाईलैंड के बैंकोक शहर में हुई पहली कार्यशाला में प्रस्तुत किया गया। कार्यशाला द्वारा दिए गए सुझावों के अनुसार क्षेत्रीय अनुसंधान कार्यक्रम को जारी रखना अति आवश्यक है।

भारत व डच प्रशिक्षण

यह संस्थान बैरकपुर में 'पर्यावरण प्रभाव का मूल्यांकन' पर एक भारत व डच (हालैंड) प्रशिक्षण कार्यक्रम का आयोजन कर रहा है। इस कार्यक्रम में देश के पर्यावरण प्रभाव के मूल्यांकन हेतु समुचित समस्याओं सहित विविध प्रणालियों के अध्ययनों को समावेश करने का प्रावधान है। इस कार्यक्रम को के.अ.प्र.मा.अनु.सं. तथा पर्यावरण विभाग, भारत सरकार संयुक्त रूप से प्रवर्तित कर रहे हैं। देश के विशेषज्ञों के अतिरिक्त नेदरलैंड के विशेषज्ञ भी इस छः दिवसीय प्रशिक्षण कार्यक्रम में भाग लेंगे।

एफ. ए. ओ. – डैनिडा (डेनमार्क) प्रशिक्षण

केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान, बैरकपुर में 'मत्स्य सम्पदा मूल्यांकन' पर एफ़. ए. ओ. – डैनिडा प्रशिक्षण कार्यक्रम, मात्स्यकी क्षेत्र में कार्यरत तकनीकी कर्मचारियों की कार्यक्षमता को बढ़ाने हेतु, आयोजित किया जा रहा है। इस योजना से संबंधित ख़र्च एफ़.ए.ओ. (खाद्य तथा कृषि संगठन) तथा डैनिश सरकार (डेनमार्क) द्वारा वहन किया जाएगा। बंगलादेश के पांच मत्स्य अधिकारियों के अलावा देश के विभिन्न राज्यों के प्रशिक्षणार्थियों को भी प्रशिक्षण दिया जाएगा।

तकनीकी ज्ञान (प्रौद्योगिकी) का हस्तान्तरण

विस्तार तथा रचनात्मक कार्य

केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान विगत वर्षों की तरह इस वर्ष भी मत्स्य पालकों, उपक्रमियों, सरकारी अभिकरणों तथा वित्तीय संस्थानों को अपनी मत्स्य प्रबंध प्रविधियों के हस्तान्तरण द्वारा विस्तार कार्यों में अग्र रहा। प्रविधियों के हस्तान्तरण कार्य निम्नलिखित पद्धतियों द्वारा किये गए हैं।

प्रशिक्षण कार्यक्रम

प्रगतिशील मत्स्य-पालकों को विभिन्न कार्यक्रमों द्वारा मत्स्य प्रबंध तथा घोंघा-पालन की तकनीकों में प्रशिक्षण दिया गया।

घोंघा पालन पर कार्यशाला व प्रशिक्षण

केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान में, समुद्रीय उत्पाद निर्यात विकास प्राधिकरण के सहयोग से संस्थान द्वारा विकसित तकनीकों के विस्तरण हेतु, घोंघा-पालन पर एक कार्यशाला व प्रशिक्षण कार्यक्रम का आयोजन किया गया। देश के बीस प्रमुख निर्यातकों ने इस नौ दिवसीय कार्यक्रम (14.6.1988 से 22.6.1988 तक) में भाग लिया। सम्मिलित हुए लोगों ने प्रकृति से प्राप्य खाने योग्य घोंघे, *एकेटिना फ्यूलिका,* की संख्या तथा प्रकृति में इसकी उत्पादन क्षमता के सम्बन्ध में काफी उत्सुकता का प्रदर्शन किया। उन्हें घोंघों के प्रजनन, स्फुटन क्रियाविधि, डिम्भक पालन-पोषण और विभिन्न पद्धतियों में घोंघा-पालन इत्यादि विषयों में ज्ञान दिया गया। प्रशिक्षणार्थियों को कलकत्ता स्थित एक प्रोसेसिंग प्लांट ले जाया गया जहां उन्हे घोंघों की प्रोसेसिंग तथा पैकिंग विधि दिखलायी गई।

सम्मिलित प्रशिक्षणार्थी इससे काफ़ी प्रेरित हुए और उन्होंने जायण्ट एफ्रिकन् स्नेल, *एकेटिना फ़्यूलिका,* का विदेशों में निर्यात प्रारम्भ करने का संकल्प लिया। इस

कार्यशाला में दिये गए 14 सुझावों से केन्द्रीय सरकार को इन उन्मुक्त जीवों के निर्यात में व्यापक सुविधाएँ प्रदान करने का आग्रह किया गया ताकि समुद्रीय उत्पादों की संख्या में वृद्धि हो ।

वर्ष 1988-89 के दौरान छः प्रशिक्षण कार्यक्रमों का आयोजन किया गया जिनके विवरण इस प्रकार हैं :-

क्रम सं॰	विषय	प्रशिक्षण की अवधि	लाभान्वित जन
1.	चाइनीज स्फुटनशाला कार्यविधि	23.3.88 – 30.3.88	डॉ॰ के॰ जी॰ पद्म कुमार केरल कृषि विश्वविद्यालय, केरल
2.	म्यूज़ियम प्रादर्श का संग्रहण तथा परिरक्षण	24.3.88 – 29.3.88	श्री इक़बाल अहमद, राजेन्द्र कृषि विश्वविद्यालय, बिहार
3.	अलवणजल मत्स्य पालन	2.5.88 – 5.5.88	प॰ बंगाल के 41 मत्स्यपालकगण
4.	कार्प मछलियों का प्रेरित प्रजनन	2.7.88	विधान चन्द्र कृषि विश्वविद्यालय, कल्याणी, के 91 छात्रगण
5.	घोंघा-पालन	14.7.88 – 22.7.88	देश के विभिन्न राज्यों के 23 निर्यातकगण
6.	मिश्रित मत्स्य-पालन	6.10.88	प॰ बंगाल के 30 मत्स्यपालकगण

सामूहिक विचार-विमर्श

प॰ बंगाल के विभिन्न क्षेत्रों में 200 से अधिक मत्स्य पालकों के लिए सामूहिक विचार-विमर्श कार्यक्रम चलाया गया ताकि अनुसंधान और इसके लाभभोगियों में बेहतर सम्बन्ध बना रहे ।

प्रदर्शन

देश के विभिन्न भागों में विविध अभिकरणों द्वारा आयोजित 4 प्रदर्शनियों में भाग लिया गया । इस संस्थान ने बैरकपुर तथा प॰ बंगाल के भोला गॉव मे दो प्रदर्शनियों का आयोजन किया ताकि जनता को मात्स्यकी क्षेत्र में हुए आधुनिक विकास की जानकारी मिल सकें ।

मत्स्य-पालक दिवस

देश के विभिन्न ग्रामों में अनेक मत्स्य-पालक दिवस मनाए गए ।

तिलहन प्रदर्शन कार्यक्रम

नौकपाल ग्राम के 4 हे॰ क्षेत्र में राष्ट्रीय तिलहन प्रदर्शन कार्यक्रम का प्रारम्भ किया गया । 15 किसानों को सरसों के उन्नत किस्म के बीज दिए गए । सालना, नागला और बलगाची के 31 किसानों को भी सरसों के बीज दिए गए ।

मत्स्य-बीज संभरण

विभिन्न सरकारी संगठनों को करीब 30,80,000 अंगुलिकाओं की व्यवस्था उनके उपयोग हेतु की गई । इसके अलावा अनेक अनुसंधान संस्थानों को चाइनीज़ कार्प और तिलापिया (*ओरिओक्रोमिस मोज़ेम्बिकस* तथा *ओ॰ नाइलोटिकस*) की फ्राइ भी उपलब्ध कराई गई ।

मत्स्य-पालकों के लिए चर्चा

इस संस्थान के विस्तार वैज्ञानिकगण ने विभिन्न विस्तार उत्सवों में 45 से भी अधिक चर्चाएं की जिससे मत्स्य-पालकों, विद्यार्थियों और विभिन्न राज्य सरकारों के विस्तार अधिकारीगण लाभान्वित हुए ।

विस्तार सम्बन्धी अध्ययन

मत्स्य-पालकों द्वारा विदेशी कार्पों को अपनाये जाने पर एक अध्ययन किया गया । इस अध्ययन से यह ज्ञात होता है कि कॉमन कार्प या ग्रास कार्प की तुलना में सिल्वर कार्प को अधिक वरीयता दी जाती है ।

एक अन्य अध्ययन द्वारा यह देखा गया कि प्रसारण माध्यमों में रेडियो ने महत्वपूर्ण भूमिका निभायी है जिसके उपरान्त समाचार पत्र, फिल्म, प्रदर्शन, मत्स्य पालक दिवस, दूरदर्शन आदि का स्थान रहा है ।

सामूहिक जागृति दिवस

हुगली जिले (प॰ बंगाल) के भोला ग्राम में एक सामूहिक जागृति दिवस का आयोजन किया गया । इस उत्सव में करीब 300 मत्स्य-पालकों ने भाग लिया ।

पुस्तकालय और प्रलेखन सेवाएँ

केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान के पुस्तकालय ने 93 नवीन पुस्तकें, 22 पुनर्मुद्रित वैज्ञानिक लेखों (रिप्रिंट्स) का संग्रहण किया है । इसके अलावा 36 विदेशी और 59 भारतीय वैज्ञानिक पत्रिकाओं की प्राप्ति हेतु सम्पर्क भी बनाया गया । पुस्तकालय में 6,121 पुस्तकें, 4146 पुनर्मुद्रित वैज्ञानिक लेख, 747 मानचित्र और 2,580 विविध प्रकाशनों का संग्रहण है । इस पुस्तकालय ने 300 से अधिक प्रमुख राष्ट्रीय तथा अंतर्राष्ट्रीय अनुसंधान सूचना केन्द्रों के साथ पुस्तक विनिमय सम्बंध बनाए रखा है । करीब

34 नए पुस्तक विनिमय सम्बंध इस वर्ष में स्थापित किये गए। यह पुस्तकालय अनेक अनुसंधान संगठनों, विश्वविद्यालयों, उपक्रमियों और मत्स्य पालकों को संस्थान के निजी प्रकाशनों को निःशुल्क भेजता रहा है ताकि वे मात्स्यकी क्षेत्र में हुई अनुसंधानात्मक विकास की जानकारी पा सकें। 62 प्रकाशन परस्पर-पुस्तकालय ऋण के रूप में अन्य पुस्तकालयों को भी दिये गए। इस वर्ष के दौरान पुस्तकालय के लिए ख़र्च की गई राशि रु॰ 3,34,876 थी।

यह अनुभाग फ़ोटोग्राफी तथा रेप्रोग्राफ़ी सेवाओं के लिए एक सक्रिय एकक बनाए है। संस्थान के वैज्ञानिकों के अतिरिक्त अनुसंधान संस्थानों और विश्वविद्यालयों को फोटोग्राफ़्स, पुनर्मुद्रित लेख और फ़ोटोकापियां निःशुल्क दी गई।

इस अनुभाग ने एक साइक्लोस्टाइलिंग और जिल्दसाज़ एकक (बाइंडिंग) को भी संस्थान के विभिन्न अनुभागों के सेवार्थ बनाए रखा है। संस्थान के वैज्ञानिकों के अनुसंधानात्मक प्रकाशनों को विभिन्न वैज्ञानिक पत्रिकाओं में प्रकाशित करने से पूर्व उनका संवीक्षण किया गया। देश के विभिन्न भागों एवं विदेशों द्वारा भेजी तकनीकी समस्याओं और प्रश्नों का जवाब भी अनुभाग के वैज्ञानिकों द्वारा प्रस्तुत किया गया।

इस अनुभाग ने संस्थान के वैज्ञानिकगण द्वारा सेमिनार, संगोष्ठी, सम्मेलन आदि में भाग लेने से संबंधित कार्यों का भी पर्यवेक्षण किया।

सूचना सेवाएँ

अनुसंधान परियोजनाओं की वार्षिक प्रगति रपटों तथा संस्थान के वैज्ञानिकों के योगदान से संबंधित सूचनाओं को प्राथमिक परियोजना फ़ाइल तथा वैज्ञानिकों की निजी फ़ाइलों में संग्रहित किया गया। अनुसंधान प्रगति की देख-रेख अनुभाग के दायित्वों में एक महत्वपूर्ण दायित्व है।

प्रकाशन

निम्नलिखित विभागीय प्रकाशनों को वर्ष अप्रैल 1988 से मार्च 1989 के दौरान प्रकाशित किया गया।

1. वार्षिक रिपोर्ट वर्ष 1987 – 88

2. बुलेटिन नम्बर 53

जाएण्ट मरेल, *चाना मेरूलियस*, धारीदार मरेल, *चाना स्ट्रायटस* और दागदार मरेल *चाना पंक्टेटस* के जैविक आंकड़ों की रूपरेखा - एस॰ परमेश्वरन और एम॰ वाई॰ कमाल ।

3. बुलेटिन नम्बर 54

सुन्दरवन के निचले क्षेत्रों में स्थित द्वीपों के विशेष संदर्भ में लवणीयजल मत्स्य फ़ार्म के लिए स्थल का चयन, सर्वेक्षण, संरचना और निर्माण – ए॰ सेनगुप्ता तथा डी॰ डी॰ हल्दार ।

4. बुलेटिन नम्बर 56

जायण्ट एफ्रीकन स्नेल *एकेटिना फ़्यूलिका* का पालन-एक नियमावली-जी॰ के॰ विन्सी, वी॰ के॰ उण्णीत्तान और वी॰ वी॰ सुगुणन् ।

5. बुलेटिन नम्बर 57

अंतर्स्थलीय प्रग्रहण मात्स्यकी स्त्रोतों के संरक्षण और प्रबंध – डा • अरूण गोपाल झिंगरन एवं वी॰ वी॰ सुगुणन् द्वारा सम्पादित (अंतर्स्थलीय मात्स्यकी स्त्रोतों पर 4–23 जुलाई 1988 केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान, बैरकपुर में हुई समर इन्सटिट्यूट में प्रस्तुत किए गए व्याख्याओं का संकलन) ।

6. बुलेटिन नम्बर 58

भारत में अंतर्स्थलीय मात्स्यकी सांख्यिकी का संग्रहण तथा आकलन प्रणालियां – एक नियमावली – आर॰ ए॰ गुप्ता, एस॰ पाल एवं एस॰ के॰ मंडल ।

7. अनुसंधान परियोजना कार्यक्रम – वर्ष 1988-89 के लिए अनुसंधान परियोजनाओं का कार्य लक्ष्य निर्धारण ।

8. 'अपशिष्ट-जल सुधार एवं मत्स्य-पालन हेतु उपयोग' पर हुई अंतर्राष्ट्रीय सेमीनार में पेश किए गए वैज्ञानिक लेखों का संकलन – डॉ॰ अरूण गोपाल झिंगरन, ध्रुवज्योति घोष एवं अपूर्व घोष द्वारा सम्पादित ।

9. अनुसंधानात्मक उपलब्धियां – 1987-88

10. केन्द्रीय अंतर्स्थलीय प्रग्रहण मात्स्यकी अनुसंधान संस्थान विवरणिका ।

APPENDIX I

Ministry/Department/Office of the Central Inland Capture Fisheries Research Institute (I.C.A.R.), Barrackpore, West Bengal. Statement showing the total number of I.C.A.R. servants and the number of Scheduled Castes and Scheduled Tribes among them as on 31st March, 1989.

Group/Class	Permanent/ Temporary	Total no. of employees	Scheduled castes	Percentage of total employees	Scheduled tribes	Percentage of total employees	Remarks
Gr. A(Cl. I)							
Permanent -							
(i) Other than lowest rung of Cl. I		80	4	5%			
(ii) Lowest rung of Cl. I total		18	1	5.56%			
Temporary -							
(i) Other than lowest rung of Cl. I		-	-				
(ii) Lowest rung of Cl. I		-	-				
Gr. B (Cl. II)	Permanent	32	8	25%	-	-	
	Temporary	1	-	-	-	-	
Gr. C (Cl. III)	Permanent	133	30	22.56%	3	2.26%	
	Temporary	32	4	12.5%	1	3.12%	
Gr. D (Cl. IV)	Permanent	148	50	33.78%	6	4.05%	
Excluding sweepers	Temporary	39	10	25.64%	2	5.12%	
Gr. D (Cl. IV)	Permanent	11	8	72.72%	-	-	
sweepers	Temporary	1	1	100%	-	-	

APPENDIX II

CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE (I.C.A.R.) : BARRACKPORE : WEST BENGAL.

Address List of Research/Survey Centres

Research/Survey Centres	Telegram/Telephone
1. **Central Inland Capture Fisheries Research Institute** Barrackpore - 743 101 West Bengal	FISHSEARCH BARRACKPORE 56-1190 56-1191
2. **Allahabad Research Centre** Central Inland Capture Fisheries Research Institute 24, Pannalal Road Allahabad - 211 002, U.P.	FISHSEARCH ALLAHABAD-2 52245
3. **Bangalore Research Centre** Central Inland Capture Fisheries Research Institute No.2421, 22 Cross, 8th Main, Banashankari II Stage, Bangalore - 560 070	FISHSEARCH BANGALORE - 3 626910
4. **Bhagalpur Research Centre** Central Inland Capture Fisheries Research Institute Khanjarpur, Beatson Road, Bhagalpur - 812 001, Bihar	1385
5. **Bilaspur Research Centre** Central Inland Capture Fisheries Research Institute Roara Sector, Bilaspur - 174 001, Himachal Pradesh	
6. **Calcutta Research Centre** Central Inland Capture Fisheries Research Institute 39, Rabindra Sarani, (3rd Floor), Calcutta - 700 073, West Bengal	

7. Canning Survey Centre
Central Inland Capture Fisheries Research Institute
R.N. Tagore Road, Canning - 743 329, West Bengal

8. **Diamond Harbour Survey Centre**
Central Inland Capture Fisheries Research Institute
House of Bidhu Bhushan Bhuiya,
New Madhavpur, P.O. Diamond Harbour,
24-Parganas (South), West Bengal

9. **Digha Survey Centre**
Central Inland Capture Fisheries Research Institute
Digha, Midnapur Dist., West Bengal

10. **Eluru Research Centre,** **FISHSEARCH**
Central Inland Capture Fisheries Research Institute **ELURU TWO**

Sastry Bhavan, **22520**
D.M.C. Home Street,
Kandukuruvarithota, Patehbad,
Eluru-2, West Godavari Dist.,
Andhra Pradesh

11. **Vadodara Estuarine Fisheries Research Centre**
Central Inland Capture Fisheries Research Institute
Gaikwad Building (Opposite Bhimnath Mahadev
Temple), Sayajiganj,
Vadodara - 390 005

12. **Guwahati Research Centre** **31717**
Central Inland Capture Fisheries Research Institute
Natun Sarania,
Guwahati - 781 003, Assam

13. **Agra Research Centre**
Central Inland Capture Fisheries Research Institute
First Floor, 'Sethi Niwas',
B-33, New Agra - 282 005, U.P.

14. **Lalgola Survey Centre**
Central Inland Capture Fisheries Research Institute,
Lalgola, Dist. Murshidabad, West Bengal,
Pin. 742 148

15. **Patna Research Centre,**
Central Inland Fisheries Research Institute,
1st Floor, Shambey House,
Kankarbagh, Patna - 800 020, Bihar

16. **Coimbatore Reservoir Fisheries Research Centrre,**
Central Inland Capture Fisheries Research Institute,
15/3, Bharathi Park Road,
7th Cross, Saibaba Colony P.O.,
Coimbatore - 641 011

17. **672401**
Central Inland Capture Fisheries Research Institute,
Flat No. 6, Indraprasta Housing Society,
Godital-Hadapsar P.O., Pune - 411 028,
Maharastra

18. **Raidighi Survey Centre,**
Central Inland Capture Fisheries Research Institute,
Raidighi, 24-Parganas (South),
West Bengal

19. **Raipur Reservoir Fisheries Research Centre**
Central Inland Capture Fisheries Research Institute,
326, 'Ashirwad',
Shankar Nagar, Near Bottle House
Raipur - 492 007, M.P.

20. **Uluberia Survey Centre**
Central Inland Capture Fisheries Research Institute,
Uluberia, Dist. Howrah, West Bengal

APPENDIX III

ORGANIZATION CHART, 1988-89

CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE
BARRACKPORE - 743 101, WEST BENGAL