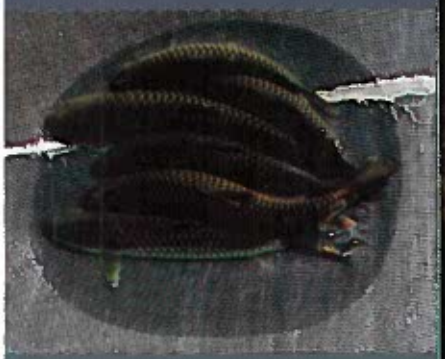
National Seminar on Aquatic Resource Management in Hills

(4th & 5th October, 2002)



Organized by

ABSTRACT PROCEEDINGS

National Seminar on Aquatic Resource Management in Hills

October 4 - 5th, 2002

Venue :

Administrative Training Institute,
Nainital (Uttaranchal)

Compiled, Composed and Edited by :

• *K. K. Vass* • *Shyam Sunder* • *A.K. Singh*
• *Ashok Nayak* • *Amit Joshi*

NATIONAL SEMINAR ON AQUATIC RESOURCE MANAGEMENT IN HILLS

Patron

Dr. Panjab Singh, Secretary, DARE & D.G., ICAR
Dr. S. A. H. Abidi, Member, ASRB
Dr. K. Gopakumar, Ex-DDG (Fy), ICAR
Dr. S. Ayyappan, DDG (Fy), ICAR

National Organising Committee

Dr. K. K. Vass, Director NRCCWF & Chairman
Dr. V. P. Agrawal, Secretary General, Society of Biosciences & Co-Chair
Dr. R. S. Tolia, Principal Secretary & F&RD, Govt. of Uttranchal
Dr. B. S. Rajput, V. C., Kumaon University
Dr. M. Y. Kamal, V. C., SUKAST, Kashmir
Dr. P. L. Gautam, V. C., G. B. Pant University of Ag. & Tech., Pantnagar
Dr. Brij Gopal, Secretary General, National Institute of Ecology
Dr. K. Janki Ram, Director, CIFA
Dr. V. V. Sugunan, Director, CICFRI
Dr. D. Kapoor, Director, NBFGR
Dr. S. Mukerjee, Director, CIFE

Local Organising Committee

Shri Rakesh Sharma, Director, ATI & Commissioner, Kumaon Division
Dr. K. K. Vass, Director, NRCCWF, Bhimtal
Shri Amit Kumar Ghosh, D. M., Nainital
Dr. H. L. Gupta, Director, VPKS, Almora
Prof. Sarvesh Kumar, Kumaon University
Dr. U. P. Singh, Dean Fisheries, GB Pant University
Dr. M. Mohan, Principal Scientist, NRCCWF
Dr. H. S. Raina, Principal Scientist, NRCCWF
Dr. C. B. Joshi, Principal Scientist, NRCCWF
Dr. Shyam Sunder, Principal Scientist, NRCCWF
Dr. B. C. Tyagi, Principal Scientist, NRCCWF
Dr. A. K. Singh, Senior Scientist, NRCCWF
Dr. Rajiv Kapila, Scientist, NRCCWF
Dr. (Mrs.) Yasmeen Basade, Scientist, NRCCWF
Dr. K. D. Joshi, Scientist, NRCCWF
Sh. Ashok Nayak, Scientist, NRCCWF
Shri R. S. Haldar, Farm Manager, NRCCWF

सुरजीत सिंह बरनाला
राज्यपाल, उत्तरांचल

राजभवन
देहरादून – 248 003

संदेश

मुझे यह जानकर प्रसन्नता हुई कि राष्ट्रीय शीत जल मात्स्यिकी अनुसंधान केन्द्र, भीमताल (नैनीताल) द्वारा उत्तरांचल मत्स्य विभाग के सहयोग से **"पर्वतीय जलीय संसाधनों का प्रबंधन"** विषय पर एक राष्ट्रीय संगोष्ठी का आयोजन किया जा रहा है ।

उत्तरांचल में जल संसाधन का उपयोग जलीय संसाधनों के रूप में मत्स्य पालन करके किया जा सकता है, जो राज्य के लिए अच्छी आय का स्रोत बन सकता है । मुझे आशा है कि सेमिनार में विलुप्त हो रही मत्स्य प्रजातियों के संरक्षण तथा मत्स्य पालन को बढ़ावा देने के उपायों पर सविस्तार चर्चा होगी, जिससे निश्चय ही पर्वतीय मात्स्यिकी एवं जलीय संसाधनों के प्रवन्धन को और अधिक बेहतर बनाने में काफी मदद मिलेगी ।

सेमिनार की सफलता के लिये मेरी शुभकामनाएं ।

हुक्मदेव नारायण यादव
HUKUMDEO NARAYAN YADAV

कृषि राज्य मंत्री
भारत सरकार
कृषि भवन
नई दिल्ली-110 001
MINISTER OF STATE FOR AGRICULTURE
GOVERNMENT OF INDIA
KRISHI BHAWAN
NEW DELHI-110 001

संदेश

मुझे यह जानकर असीम प्रसन्नता हो रही है कि राष्ट्रीय शीत जल मात्स्यिकी अनुसंधान केन्द्र, भीमताल (नैनीताल) **"पर्वतीय जलीय संसाधनों के प्रबंधन"** विषय पर एक राष्ट्रीय संगोष्ठी दिनांक 4 एवं 5 अक्टूबर 2002 को नैनीताल में आयोजित कर रही है । यह एक विदित तथ्य है कि देश के पर्वतीय अंचलों में उपलब्ध खाद्य पदार्थों में मछलियों का सदैव ही विशिष्ट स्थान रहा है । आज जब पर्वतीय क्षेत्रों में मछली की उपलब्धता अविवेकपूर्ण दोहन एवं विनाशकारी गतिविधियों के कारण कम हो रही है, इस विषय पर राष्ट्रीय संगोष्ठी का आयोजन सम सामयिक है ।

मुझे पूर्ण विश्वास है कि राष्ट्रीय शीत जल मात्स्यिकी अनुसंधान केन्द्र का यह रचनात्मक प्रयास पर्वतीय प्रदेशों में खाद्य एवं पोषण सुरक्षा प्रदान करने हेतु उल्लेखनीय भूमिका निभाएगा । मैं इस संगोष्ठी की सफलता हेतु अपनी शुभकामना प्रेषित कर रहा हूँ ।

मंत्री प्रसाद नैथानी
मंत्री
सहकारिता, पशुपालन
दुग्ध विकास एवं मत्स्य पालन

उत्तरांचल शासन

विधान भवन,
देहरादून
0135–660381 (कार्यालय)
0135–722866 (आवास)
0135–669382 (फैक्स)

संदेश

यह हर्ष का विषय है कि राष्ट्रीय शीत जल मात्स्यिकी अनुसंधान केन्द्र भीमताल (नैनीताल) द्वारा दिनांक 4 - 5 अक्टूबर 2002 को **"पर्वतीय जलीय संसाधनों का प्रबन्धन"** विषय पर एक राष्ट्रीय सेमिनार का आयोजन किया जा रहा है ।

मत्स्य पालन कार्यक्रम समाज के कमजोर वर्ग - मत्स्य पालकों से जुड़ा है । इसको विकसित करने की आवश्यकता है, ताकि उनकी आर्थिक स्थिति सुदृढ़ हो सके। मत्स्य विकास की दृष्टि से उत्तरांचल में पर्याप्त सम्भावनाएं उपलब्ध हैं, जिनका उपयोग करके ग्रामीण अंचल में रोजगार, पोषण तथा मनोरंजन के साधन सुलभ कराये जा सकते है जलीय वातावरण को संतुलित रखने में मछली की अहम भूमिका है। मत्स्य विकास की गति निरंतर बनी रहे , शोध संस्थानों द्वारा राज्य के लिये ऐसे कार्यक्रम प्रस्तावित करने की आवश्यकता है ।

सेमिनार की सफलता के लिये मेरी शुभकामनायें ।

(मंत्री प्रसाद नैथानी)

HISTORY, BRIEF ACHIEVEMENTS & GROWTH OF NATIONAL RESEARCH CENTRE ON COLDWATER FISHERIES (ICAR), BHIMTAL

K.K.Vass
Director

Implementing the suggestions/recommendations of various high-powered committees and also of VII plan working group, the ICAR in the year 1987 established the NRCCWF as a new scheme that in course of time, be a full Institute. After a great thinking at ICAR level, in the year 1996, the headquarters of this important center was decided at Bhimtal, which is now a part of new State, Uttaranchal.

MANDATE

Keeping in view the emerging and priority areas in this sector the center was assigned tasks / mandate to undertake following activities:

- Evaluate and assess the coldwater fishery resources in upland regions
- Develop strategies for their conservation and management
- Conduct research leading to development of suitable farming technologies for indigenous and exotic fish species
- To study the environmental changes and biodiversity in upland open-waters
- Undertake transfer of technology, training and extension education in the sector
- Offer consultancy and other services in the area.

GROWTH

In terms of Growth of research centre, the efforts in creating infrastructure facilities during the last five years has been as per schedule and it is expected that by X plan most of the facilities will be in place. The budgetary support during IX plan has been adequate. But manpower support at all levels *viz.*, scientific, administrative, technical and supportive has been inadequate, this has hampered the higher achievement in certain programmes.

FACILITIES

RESEARCH ACHIEVEMENTS

As per the VISION document 1995 - 2005 in a ten-year period, 12 thrust areas have been listed and some of them being continuous programmes. After the release of VISION document the implementation was initiated from 1997. Therefore, for five year period, the research programme activities, keeping in view the philosophy of VISION document were formulated in consultation with Staff Research Council and the Research Advisory Committee. Accordingly following listed programmes falling under capture fisheries and aquaculture were investigated.

- Structure and Production functions in Lakes / Wetlands
- Riverine Ecology and Biodiversity
- Seed Production and hatchery development for golden mahseer
- Seed production and brood stock development in case of snow-trout
- Feed development for indigenous upland fishes
- Induced spawning and ovarian development in Exotic carps
- Demonstration of Exotic carp farming
- Trial raising and maturation of rainbow trout stocks in warmer region of Kumaon Himalayas.

IMPACT

During the last five years, the main impact of our work in the region has been formulating management action plan for system and species conservation. Initiating work on high mountain lake ecology in the entire Himalayan belt, the other most significant impact has been introduction of rainbow trout in the region, its successful farming by NRCCWF at Champawat. The centre has been able to create awareness about exotic carp based aquaculture in the Kumaon region, number of demonstration sites have been brought under the carp aquaculture and now more and more farmers are evincing keen interest in this activity. These are visible impacts of our activities during last couple of years. In fact two progressive farmers one each in Nainital and Champawat district were suitably awarded by the Hon'ble MOS, DARE, ICAR in March 2001 for achieving highest fish production in their respective regions. Further, evidence of impact has been the recent award of consultancies by different organizations in the field of coldwater fisheries development. The visibility of impact has been a sustained demand by large number of end users for the publications on coldwater fisheries released by the centre in recent years.

OUTREACH

In order to make the information on coldwater fisheries available to various users

aquaculture in the state. The institute has also initiated international linkage in this sector through NACA.

EXTERNAL PROJECTS AND CONSULTANCY

Having recognized the expertise of NRCCWF scientists in coldwater fishery sector, three projects are currently in operation. The institute has also been awarded consultancies by Tehri Hydel Development Corporation, Alternate Hydro Energy Centre of IIT , Roorkee, Govt. of Uttaranchal, State Fisheries Resource Management Society, Kerala, Travencore Leisure Management, Kerala, and RITES

CHANGE IN SCENARIO

We find that during last five-year period more awareness is there among the authorities in the hill states to develop their fishery resources and have established linkage with our Centre. Even the message about the benefits and viability of aquaculture in hills has gone to the local farming community. The most important scenario change has been the realization at national planning level, the need and priority for hill resources development in which the aquatic resources and fish is an integral component. It is expected that during X plan this sector would receive more support. High mountain aquatic resource management should focus strongly in such programme activities due to placement of our Armed forces in advanced hill areas.

RESOURCES

It is found that resource base for coldwater fishery development is slowly increasing with more and more fishery development programmes being implemented across the hill states. But during this period, a major addition to coldwater fishery resource in the country has been in the State of Uttaranchal in the shape of Tehri Dam in Garhwal region

STRENGTH

The coldwater sector by the X Plan will have full-fledged institutional back-up facilities at Bhimtal to cater to the research needs of the sector in general and also address the specific problems of the state of Uttaranchal. Further, efforts will be made to address the issues of this sector in the Northeastern region, which has not been looked into.

POLICY SUPPORT & THREAT

A national level policy on the development of coldwater fisheries has not been addressed properly. In the absence of such a policy the focus on conservation and

aquatic resource management in hills. In fact, serious attempt should be made to translate environmental / biodiversity loss or ecosystem loss into monetary terms so that planners and administrative authorities are appreciative of any proposed conservation action plan.

PERSPECTIVE

The Coldwater Fisheries R&D in the country requires NRCCWF to address the problems of hill capture fisheries involving resource evaluation in the entire Himalayan region and Deccan plateau (extending from Northern, Eastern Himalayas to Southern uplands), generate suitable technologies for coldwater aquaculture and conservation of stocks and resources. A small NRC cannot address this magnitude of scientific demand which was created in VII plan. Now with the Centre's own building and other facilities coming-up and scheduled to be ready by end of 2002, it is the need of the sector that NRCCWF be elevated to the full-fledged institute during X plan. This will provide much needed outreach to extend our activities.

REPORT OF SOCIETY OF BIOSCIENCE

25/4, Ram Bagh Road, Muzaffarnagar

"*Society of Biosciences*" was constituted, registered and launched in 1982 with head quarters at Muzaffarnagar Padam Bhushan Dr. S. Z. Qasim, Former Secretary, Department of Ocean Development, Govt. of India, New Delhi is its Charter President whereas Dr. V. P. Agrawal, Former Principal, D.A.V. College, Muzaffarnagar is the Secretary General. Many other renowned Biologists of the country and abroad have agreed to be associated with this society.

The society aims to generate co-ordinate and promote quaility reserach in Biological Sciences through association between senior and young Scientists. Dissemination of knowledge will be affected through training, seminar/symposia, books and journals. A liason between Govt. and Scientists will be established to solve national problems.

Members will hold the privilege of running this Society . In addition to free supply of the Journal Advances in Biosciences, other publications, will be made available to them at a reduced rate.

Fellowship of the society (F.S.B.) is also given to the distinguished Bio-Scientists.

Your advice co-operation is sought to make this effort a successful venture. Your esteemed suggestions are also welcome.

SEMINAR/SYMPOSIA/WORKSHOP

• 1982	D.A.V. College, Muzaffarnagar	Environment & Natural Resources
• 1986	D.A.V. College, Muzaffarnagar	Science, Development & Environment
• 1988	Moradabad	Threatened Habitat
• 1989	N.I.O., Goa	Management of Aquatic Ecosystems
• 1990	Garhwal University, Srinagar	Recent Trende in Limnology
• 1991	Meerut University, Meerut	Environment & Biodegradation
• 1992	Behrampur University, Orissa	Environment Impact on Aquatic & Terrestiral Habitat
• 1992	D.A.V. College, Muzaffarnagar	Workshop of Retired Scientists was held at Muzaffarnagar sponsored by D.S.T.
• 1993	Bareilly	Environment & Applied Biology
• 1994	Roorkee University, Roorkee	Complex Carbohydrates
• 1995	M.D. University, Rohtak	Recent Advances in Bioscience

- 1999 D.A.V. College, Muzaffarnagar — Conservation of Biodiversity
- 2000 Dr. B.R. Ambedkar Univ., Agra — Role of Bioscience in new millennium
- 2001 C.I.F.E., Mumbai — Workshop on Basic Science & Fisheries

PUBLICATIONS OF THE SOCIETY

- Progress in Ecology in 6 volumes
- Reading in Basic and Applied Zoology
- Environment and Natural Resources
- Recent Trends in Biotechnology and Biosciences
- Threatened Habitats
- Management of Aquatic Ecosystem
- Environment Strategies and Biosciences
- Recent Trends in Limnology
- Environment and Biodegradation
- Environment Impact on Auqatic & Terrestrial Habitats
- Environment and Applied Biology
- Complex Carbohydrates
- Recent Advances in Biosciences and Oceanography
- Chemistry & Biology of Herbal Medicines
- Environment & Health
- Recent Trends on Aquaculture
- Environment & Health
- Paryavaran Sanrakshan

GOLD MEDALS OF THE SOCIETY

The society has introduced five Gold Medals (1) Prof. K. N. Bahl Memorial Gold Medal for Senior Scientist (2) Norman H. Dill Memorial Gold Medal (3) Zahoor Qasim Gold Medal for the Young Scientist below the age of 45 (4) A Gold Medal has also been instituted for the best article in the Journal, each year (5) Another Gold Medal is given to the Junior Scientist for the best paper presentation during the Seminar.

K.N. BAHL MEMORIAL GOLD MEDAL AWARDEES

- 1985 Dr. S.Z. Qasim — Padam Bhusan, Secretary Department of Ocean Development, Govt. of India
- 1987 Prof. M.L. Bhatia — First Professor of Delhi University
- 1988 Prof. V. Puri — Professor of Botany, Meerut University Fellow of INSA from 1957. Birbal

⁜ 1989	Prof. M. L. Roonwal	Vice-Chancellor of Jodhpur Univesity
⁜ 1990	Prof. P. N. Srivastava	Vice-Chancellor, J.N.U., Member Planning Commission
⁜ 1991	Dr. K. Alagarswami	Director Central Institute of Brackish water Aquaculture
⁜ 1992	Prof. H.Y. Mohan Ram	Professor of Botany, University of Delhi, Delhi
⁜ 1993	Prof. T. J. Pandian	Head & Coordinator, School of Biological Sciences, Madurai Kamraj University, Madurai
⁜ 1994	Dr. V. P. Kamboj	Director, C.D.R.I., Lucknow
⁜ 1995	Prof. K. C. Pandey	Vice Chancellor, Ch. C. S. University, Meerut
⁜ 1996	Dr. E. Desa	Director, National Institute of Oceanography, Goa
⁜ 1997	Dr. (Mrs.) Manju Sharma	Secretary, Dept. of Biotechnology
⁜ 1998	Dr. R. S. Paroda	Director General, ICAR New Delhi
⁜ 1999	Dr. Panjab Singh	Director General, ICARNew Delhi
⁜ 2000	Dr. Harsh Gupta	New Delhi.
⁜ 2001	Dr. Lal ji Singh	Hyderabad

ZAHOOR QASIM GOLD MEDAL AWARDEES

⁜ 1987	Dr. M.D. Zingde	Scientist-in-charge, N.I.O., Bombay.
⁜ 1988	Dr. P. Murali	Reader and Head, Division of Neurology, S.V. University, Tirupati
⁜ 1989	Dr. Vinay Sharma	Plant Physiologist in Roorkee University.
⁜ 1990	Prof. W. A. Nizami	A.M.U
⁜ 1991	Dr. S.V.S. Rana	Ch. C.S.University, Meerut
⁜ 1992	Dr. Sandeep K. Malhotra	Reader in Zoology, University of Allahabad
⁜ 1993	Prof. Ravi Prakash	M.D. University, Rohtak
⁜ 1994	Prof. Mohd. Akhtar	Hamdard University, Delhi.
⁜ 1995	Dr. Baban Ingole	N.I.O., Goa
⁜ 1996	Dr. Dinabandhu Sahoo	Deptt. of Botany, University of Delhi, Delhi
⁜ 1997	Dr. A. Ayyappum	Dy.-Director, General (Fisheries), ICAR, N.Delhi
⁜ 1998	Dr. A.K. Pandey	Bhubneswar

NORMAN DILL MEMORIAL GOLD MEDAL AWARDNESS

* 1994	Dr. P.V. Dehadrai	Dy. Director General (Fisheries), I.C.A.R., New Delhi
* 1995	Dr. S.A.H. Abidi	Director, Central Institute of Fisheries Education, Bombay
* 1996	Prof. Faizan Ahmad	Head, Deptt. of Biosciences, Jamia Milia Islamia University, New Delhi
* 1997	Dr. P.K.Seth	Director, I.T.R.C., Lucknow
* 1998	Prof. P.K.Gupta	Head Deptt. of Agriculture, Ch.C.S. Univ., Meerut
* 1999	Dr. C.M. Gupta	Lucknow
* 2000	Dr. Satish R. Shetya	N.I.O., Goa
* 2001	Dr. K.K. Vass	Director NRCCWF, Bhimtal

One or two Gold Medals are also awarded to the best paper presented by the young students during each symposia.

JOURNAL ADVANCES IN BIOSCIENCES

The journal war released in 1982 and The Journal is uptodate since then the journal is supplied free to all members.The 21st issue has come out.

OFFICE BEARER OF THE SOCIETY

President
Dr. S.Z. Qasim, New Delhi

Vice Presidents
Dr. Panjab Singh, New Delhi
Prof. C.B. Sharma, Roorkee
Dr. C.M. Gupta, Lucknow
Dr. P. K. Seth, Lucknow

Secretary (Local)
Dr. S.V.S. Rana, Meerut

Secretary (Outstation)
Dr. L.D. Chaturvedi, Moradabad

Secretary (Foreign)

Secretary General and Treasurer
Dr. V. P. Agrawal, Muzaffarnagar

Councellor
Prof. S. C. Rastogi , Delhi
Dr. R.K. Sharma, Bareilly
Dr. A. K. Pandey, Bhubaneswar
Prof. H.R. Singh, Allahabad
Dr. S. N. Chaturvedi, Agra
Dr. K.K. Vass, Bhimtal
Prof. Ravi Prakash, Rohtak
Dr. M.D.Zingde, Mumbai
Dr. Lal Ji Singh, Hyderabad
Dr. Mohan Joseph Modayil, Cochin

CONTENTS

POLICY INITIATIVES FOR COLDWATER FISHERIES IN INDIA : OPPORTUNITIES, PERSPECTIVE AND CHALLENGES

S. N. Dwivedi
President, Academy of Science, Engineering & Technology

E-1/106, Arera Colony, Bhopal - 462016

OBJECTIVES

The major challenge for development of coldwater fisheries in India is to provide fish to meet the nutritional needs of people living in high altitudes where other sources of animal protein and fresh food are scarce and to develop sport fisheries, angling, ornamental fisheries alongwith tourist resorts based on eco-tourism for national and international tourists. This will help in generating High-Tech and environmental controlled systems for aquaculture and develop *Aquatic Santacureies* for conservation of aquatic resources of high altitude lakes and rivers. It will also help to generate employment and income through ancillary industries like live feed culture, formulated feed, equipment for making convenient food products and fast food outlets. In an integrated approach and to benefit local people and provide wholesome food for tourists, efforts must be made to develop fish based fast food outlets. This approach along with *Custom Cuisin* based on traditional dishes of the region can attract high value international tourist industry to enjoy pristine Himalayan ecology.

DATA BANK FOR ECOSYSTEM AND COLDWATER RESOURCES, FLORA AND FAUNA

The devlopment of High-Tech coldwater fisheries needs creation of a data bank of aquatic resources both fauna and flora, a museum and large aquaria to cultivate and demonstrate colourful hill-stream fishes in their natural environment. At present, information on fish fauna dates back to sixteenth century work of Sir Francis Day. This has become outdated and requires survey of Himalayan rivers to study their ecology, fish fauna and biological and geographical distribution of different species in the special temperate and coldwater ecosystem, particularly of Himalayan lakes and rivers which get frozen for a large part of year but still harbour a large variety of fishes, some of

species suggested for this study are mahseer *(Tor putitora)* and snow trouts (*Schizothoraichthys* and *Schizothorax* Spp.)

VOCATIONAL, EDUCATION AND SKILL DEVELOPMENT (Conservation and awareness programme, aquaculture and post-harvest technology for fishing, fish processing, packaging and marketing of fast food through restaurant specialising in fish preparations and delicacies)

Himalayan region does not have any fishermen community and the local inhabitants of the hilly region catch fish to meet their needs. Modern fishing gear and tackle are not common in this region and dynamiting the water bodies is a common practice for catching fish. This not only destroys the fauna and flora of the area but also adversely affects the bio-diversity of the region. Therefore, conservation of rivers and creating awareness among fishermen that fish is a sustainable resource and can provide them food and income, needs immediate attention. Therefore, vocational and educational services are priority sectors for development of aquaculture. It is also proposed to develop a few sanctuaries for fish with people's participation.

NRCCWF has made efforts to promote carp based aquaculture in Nainital and Champawat districts. They have undertaken fish culture demonstration with defence organisation namely Sainik School, Ghorakhal. At this centre, through vocational education and fish culture demonstrations at the farm, the students learn aquaculture technology and farm management. From this culture system, school authorities serve fish preparation in the menu of hostel students, at least twice a week. Thus, the students have personal knowledge and experience that fishes can grow in this region and provide both food and income. This is an enterprising and encouraging project for creating awareness and conducting practical demonstrations for aquaculture in high altitudes. The school authorities have offered to extend this vocational education programme and allot more land for enlarging the demonstration. It will be useful to support this project through ICAR Cess fund.The S&T intervention through Deptt. of Science & Technology to demonstrate area specific technologies will also be very useful. It is recommended to set up a *centre of excellence* in this area, where S&T officers, entrepreneurs from Science Departments and Science Research Councils of different states can be given orientation and short-term training programmes for aquaculture . In the meeting of S&T Councils which was held at Sikkim, it was recommended taking up aqua-culture for hill states. Northeastern States should be given high priority. It is thus seen that vocational education for aquaculture can be very useful and effective for providing manpower training and creating awareness.

CENTRE FOR EXCELLENCE IN COLDWATER FISHERIES AND INTERNATIONAL CO-OPERATION (exchange programme for scientists and research scholars)

A laboratory building is under construction for National Research Centre on Coldwater Fisheries at Bhimtal, Uttaranchal. This is a very encouraging development but it should be supported by establishment of an *International Centre of Excellence for Coldwater Fisheries*. This will help in establishing exchange programmes with various countries in Europe, America, Australia, New Zealand and Japan. These countries have developed excellence in different aspects of coldwater fisheries and have indicated interest in developing programmes. Norway alongwith the Govt. of J&K has established successful trout culture by bringing new fast growing trout strains. This has became a success and has been greatly appreciated. Establishment of farms at high altitudes for culture of snow-trout also requires immediate attention. Other programmes which require attention are study of fishery ecology of Himalayan lakes and rivers including genetic selection and improvement of indigenous stocks of fishes through natural selection and genetic upgradation of indigenous culture species. Programme on ecology and enhancement of fisheries in Himalayan lakes, farming of exotic species in coldwater, knowledge systesm for coldwater fisheries and resource management, culture of mahseer *Tor putitora*, development of live food and production of formulated fish feeds for trout and mahseer etc. are the areas which deserve greater attention.

CULTURE OF EXOTIC SPECIES FOR COLDWATER ECOSYSTEMS

The culture of exotic carps, particularly silver carp have shown excellent results in Himachal Pradesh. In this area, the temperature and environmetnal conditions are suitable for silver carp. This species has shown large-scale production in Gobindsagar reservoir. In order to produce large scale biomass, to meet the food requirements of the people and generate employment, it is recommended to examine possibilities of screening and culture of other exotic fish species which may be suitable for this region . However, this may be done under controlled conditions to ensure that the introduction of the exotic species does not adversely affect the indigenous flora and fauna. In the above experiments, NRC has obtained a production of 4059 kg of fish in ponds located at the altitude of 4000-5000 ft above mean sea level. In this area, suitable temperature and growing period is very short . Therefore, *Relay Culture* and stocking of large size fingerlings and culturing them for 60-90-120 days should also be attempted. However, alongwith the fish culture, development of post-harvest technology for preservation, packing and developing fast fish food products also need higher priority. It will be useful to set up *Fish Food Counters near tourist resorts* to provide new avenues of income for local people

DEVELOPMENT OF SPORT FISHERIES, ANGLING AND ECO-TOURISM

Trout and mahseer are very important sport fishes of this region . It is necessary to set up fish farms at different altitudes to meet the ecological needs of the concerned species. Sport fisheries, angling and tourism are tested technologies those are commercially viable and can attract, if interdisciplinary efforts are made to develop tourist cottages alongwith the fish farm and river sanctuaries and lakes . This will help in effective utilisation of research results and open flood gates for prosperity of the region through international sport based natural tourism . It will also be helpful to develop joint-ventures with private organisations. M/S Tata Power Company Ltd. Lonavla, Pune has successfully established a centre for conservation and angling of mahseer under the guidance of Late. Dr. C.V. Kulkarni and Shri S. N. Ogale. Establishment of local museum, aquaria and fish sanctuaries can become a source for international attention. It will help in attracting research scholars and professors from different parts of the globe to establish exchange programme for conducting post-graduate education and research to Master's and Ph.D degrees from different universities. This educational exchange should be established under networking programme of CIFE, Mumbai, NRC on Coldwater Fisheries, Bhimtal and Education Division of the ICAR .

GREATER BUDGET ALLOCATION FOR RESEARCH AND DEVELOPMENT AND COMMERCIALLY VIABLE PROJECTS

A review of the work done on coldwater fisheries indicates that the Government of India, ICAR and State Fisheries Deptt. have paid marginal attention of coldwater fisheries but much more needs to be done. Development of coldwater fisheries is essential for improving quality of life of the people in the region . It will provide food and self employment to people living in high altitudes and generate tourism for the affluent classes. This region has also potential to develop large-scale international programmes on aquatic biotechnology and development of new process and products based on coldwater fisheries. It is in this area that the introduction of *knowledge systems* for management of coldwater fisheries can bring about new industrial ventures .Therefore, it is necessary that the *planning commission* allocates substantially large budget for development of sport fisheries (Mahseer and Trout), coldwater aquaculture, establishment of aquaria and Natural History Museum for aquatic resources to develop tourist based sport fishery in the region .

MISSING PRIORITIES IN COLDWATER FISHERIES DEVELOPMENT

P.V. Dehadrai
Ex. Deputy Director General (Fisheries)

Indian Council of Agricultural Research
New Delhi

High altitude colder aquatic eco-regime are nature's unique gift to a tropical country like India and those deserve a priority attention for long term benefits to the people of the country. In these ecosystems, efforts on fisheries development could not be possibly unilateral concerning fish alone, but would have to be through an integrated approach. Related fauna and flora, the habitat in its entirety as well as the impact of human interference would have to be subject of concern with fish and the people at the centre stage.

PRESENT STATUS OF COLDWATER FISHERIES

The ecological conditions of the fishery resources of the upland areas namely coldwater streams, brooks, rivers, natural and man-made lakes are quite different from that of the plains. There are two types of streams namely snow-fed and springs fed. These streams are characterized by rocky and gravely bottoms, high transparency, low temperature, high oxygen level due to high velocity and continuous water flow and their low primary and secondary productivity. Temperature plays a crucial role in the occurrence and distribution of fishes in these areas. The other factors, which play key role in the distribution of fishes, are swiftness of current, nature of substratum and availability of food. The fishes of the upland water-bodies have either strong power of locomotion (mahseer) or have developed special organs of attachment (*Garra,* Sisorids) in the fast turbulent streams. These fishes are of small size in contrast to the warm water fishes. On the basis of temperature tolerance, the fishes of the upland areas are classified into eurythermal type (wide range of temperature tolerances *i.e. Schizothorax* and *Barilius*) and stenothermal type (narrow range of temperature tolerance, *i.e.* exotic trout). The common fishes inhabiting the upland streams of the Kashmir, Himachal Pradesh, Uttaranchal, North West Bengal, Sikkim, Arunachal Pradesh, Nagaland, Meghalaya and Nilgiris, Kodai hills and Munnar high range of the Peninsular India are presented in Table 1.

Table : 1 Common fishes of upland areas of the Himalaya and Peninsular Plateau

Group	Family/Sub family	Fish species
INDIGENOUS		
Mahseer	Cyprinidae/Cyprininae	*Tor putitora, T. tor, T. khudree, T. mosal Neolissocheilus hexagonolepis*
Snow trout	Cyprinidae/Cyprininae	*Schizothroax richardsonii, Schizothoraichths curvifrons, S.niger, S. labiatus, S. progastus S. esocinus.*
Barils	Cyprinidae/Rasborinae	*Barilius bola, B. barila, B. vagra*
Minor carp	Cyprinidae/Cyprininae	*Labeo dero, L. dyocheilus*
Loaches	Cobitidae	*Botia* spp., *Nemacheilus* spp.
Catfishes	Sisoridae	*Glyptothorax pectinopterus, Glyptosternum reticulatum*
EXOTIC		
Trout	Salmonidae	*Oncorhynchus mykiss, Salmo trutta fario, Salvelinus fontinalis*
Common carp	Cyprinidae	*Cyprinus carpio communis, C. carpio specularis, C. carpio nudus*
Tench	Cyprinidae	*Tinca tinca*

Source : NRCCWF (ICAR), Bhimtal

The capture fisheries in the upland water-bodies of Himalayan region and Peninsular India are poorly developed primarily due to low natural fish yield, difficult terrain and its inaccessibility.

Hill stream fish form a meager commercially important fisheries. Nevertheless, the snow trout, *Tor* spp., common carp and few minor carps form subsistence level fishery for the poor for food and sale. In cold waters, the fish growth is slow, fish fetch low price and the cast net like gear is more of an individual effort. Transporting fish from remote areas is not convenient for marketing.

Uttaranchal, North Bengal, Niligiris, Kodai hills and Munnar High ranges offer excellent sport opportunities for tourists and anglers. Sport fishery yields considerable revenue in Jammu and Kashmir. Trout alone contributes to about 40% of the state's revenue from fisheries.

The population pressure has adversely affected the fragile upland ecosystem. The resource ecology, the aquatic habitat and their biodiversity are all under grave stress due to felling of forest trees, doming of rivers and streams. To add to the malaise, the natural calamities of rock-falls, land slides, avalanches, cloud bursts worsen the situation. As a result, the ecosystems such as the valley lakes in Kashmir, Kumaon lakes, Ooty lake in Western Ghats and Loktak Lake in Manipur have reached higher trophic levels and as such cannot sustain fish species which it used to be earlier.

CULTURE PRACTICES

In the mountain areas of the country, fish cultivation is carried out in the tanks ponds, running water raceways. The fish farming or aquaculture of coldwater fish has been historically a small scale activity in the mountain areas of the country. The reasons are culture techniques of important coldwater species are far from perfect and research efforts to improve technologies are in the process of completion. Aquaculture programmes in coldwater fisheries have longer gestation period in comparison with fisheries in warmer waters or other forms of food production. Practically every facility created in the Indian upland hills, the aim to produce fish seed or stocking material to meet primarily the requirements of sport fishing waters. The aquaculture commenced with the introduction and transportation of certain exotic fish species of trout as early as in 1867.

The activities of culture fisheries in the mountain region remained confined to the states in their respective coldwater regimes. Majority of these facilities date back to the beginning of the last century and suffer from changing thermal regime, increased in flow of silt-load in water supply from hills due to erosion and lack of adequate quantity of nutritive feed, fish health management etc. This resulted in poor survival and growth rate in the farms. The result of research conducted till date have improved the survival in trout hatcheries by brood stock management, prophylactics against diseases and supply of highly oxygenated water to individual hatchery units. These resulted in increase of survival in hatcheries up to swim-up fry as high as 93% as against 20% by conventional method. The transfer of this technology in other hatcheries resulted in enhancing of survival to 90%. Two important trout farms were establishment at Patlikuhl (H.P.) and Kokernag (J&K).

rainbow trout. The Project is to support the private entrepreneurs to construct small raceways connected with natural streams in the hills and provides them trout fingerlings from the hatcheries for table-size trout production and generate a substantial income.

HIMACHAL PRADESH TROUT FARM

A modern trout farm was constructed with the help of Norwegian Government at Patlikuhl Farm near Kullu. The first consignment of "eyed-ova" was procured from Norway in April, 1991 and hatched in this farm with a survival of 90%. About 35,00 fingerlings were stocked in rivers. Trout feed mill was also installed. For the first time in India, private farmers purchased fingerling from this farm and cultured the fish to table size for sale in the open market.

Details of trout production under Indo-Norwegian project at (H.P.)

Sl. No.	Items	1996-97	1997-98	1998-99
01.	Eyed ova imported (lakhs)	2.25	1.50	-
02.	Survival of eggs to fry (%)	88.7	88.0	-
03.	Seed stocked in different waters (No.)	79,352	12,877	56,861
04.	Seed provided to private farmers (No.)	7,500	69,000	4,000
05.	Feed manufactured (kg)	6,790	3,368	19,992
	-distributed to departmental farms (kg)	5,511	10,952	14,762.5
	-sold to private farmers(kg)	1,279	3,368	5,086.5
	-revenue earned (Rs.)	45,020	1,34,265	2,13,995
6.	Sale of fish (kg)	827.630	2479.750	5271.350
	-revenue earned (Rs.)	1,81,000	2,98,962	6,32,562

Source : Deptt. of Fisheries, Government of H.P.

JAMMU & KASHMIR TROUT FARM

One 10.5 ha modern trout farm with technical guidance from EEC was constructed

Commercial production details of Kokalnag farm (J&K)

1st Phase	
Commercial production started in May 1996; Weight of fish at marketable size about 150 g	
Production during 1986-87	40 tons
Production during 1987-88	50 tons
Production during 1988-89	55 tons
Production during 1989-90	60 tons
Production during 1990-91	60 tons
2nd Phase	
Production during 1991-95	100 tons
Production during 1995-2000	500 tons

Source : Deptt. of Fisheries, Govt. of J&K.

CULTURE OF COLDWATER FISHES

Aquaculture of mahseer species (*Tor khudree* and *T. putitora*) commenced in the seventies to counter the sharp decline in catches of mahseer in different natural habitats of India. Simultaneous efforts to induced breed mahseer species met with success at Lonavla in Maharashtra and at Bhimtal and Dehradun in Uttaranchal. The techniques to induce breed the two species involved catching of ripe spawners from the lacustrine environment and stripping and artificial fertilization. Two hatcheries for mahseer have been developed at Lonavla and Bhimtal. In the pond culture, the experiments did not yield satisfactory growth. In the first year the growth was 180-200 (total length 200-240 mm) and in the second year 250-355 g, (total length 250 - 350 mm). Mahseer cultured in ponds has also been bred by using ovaprim and pituitary gland successfully.

The attempt to evolve technology for aquaculture of certain species of Schizothoracids have met with partial success. The stripping and artificial fertilization by a ripe spawners of *Schizothoraichthys esocinus, S. curvifrons, S. longipinnis S. niger* and *Schizothorax richardsonii* from the brooders collected from streams and lakes were successfully done. Rearing of fry to fingerlings and raising of broodstock of *Schizothorax richardsonii* by using artificial feed has been achieved at NRC's fish farm at Champawat.

The common carp and exotic carp species have been bred and cultured in several parts of Indian uplands, where the approach of mixed farming using both indigenous and exotic carps has also been tested by NRCCWF with a production of above 2000 kg/ha/yr

FUTURE STRATEGIES

Besides aquaculture of potential fish species of commercial importance with assured economic gains, scientific feasibility and sustainability, the main thrust in the colder regime needs to be on conservation of fish species as well as the related fauna and flora protecting the habitat. There is need for pragmatic strategies to avoid fruitless efforts to bring difficult fish species under aquaculture protocols.

In regard to conservation of these eco-regime, there are neither any exclusive aquatic ecosystems designated as Biosphere Reserve (BR) nor any high altitude water body recognized as a Ramsar site. In fact the BR of an aquatic eco-system could also be a part of a larger BR comprising of the forest, its land scape and the biodiversity influencing the water body ecology with an integrated approach in cooperation with the larger inhabitation.

There are, however; records if inventory, monitoring and conservation of aquatic biodiversity of Dhauliganga fluvial ecosystem of Nanda Devi BR, Similipal BR, Sundarbans BR, Nokrek BR as well as several marine BRs such as Gulf of Mannar and A & N Islands etc.

The gene pool of the unique fauna of cold water regime is a valuable endowment of nature. Low temperature tolerance command genes, if isolated, could change the utility of tropical fishes. Conservation of these germ plasm therefore are essential.

HIGH ALTITUDE AQUATIC BIOSPHERE RESERVE

At least one representative site in the high altitude may be identified for the network of BRs conservation of aquatic ecosystems, species and genetic variations, promote sustainable economic development and to provide logistic support for research, monitoring, education and information dissemination are some of the important aspects of BRs. Conservation may be absent altogether within certain parts of buffer zone where the emphasis could be on the sustainable use of natural resources for livelihood. Therefore, the BR may have a Core Zone and a Buffer Zone (Rai, 2000).

BR would essentially need to be studies with a focus on a defined set of species and their diversity along with the individual population of supporting fauna/flora associated with the soil and water of the eco-system, demarcation of core zone for conservation, characterization of the catchment areas, different habitat, classifications etc. using tools such as GIS in coordination with ground truth information.

People's participation through local Govt. Agencies, Institutions concerned, NGO, should be the systems for management preferably under single umbrella. Management of such BRs may be under the state Govt. with financial support from the Central Govt. One of the dilemas in the establishment of BRs is the size, shape and design of the BR. In regard to

RESEARCH STRATEGIES OF AQUACULTURE IN UPLAND WATERS

M. Yusuf Kamal
Vice Chancellor

Sher-e-Kashmir University of Agriculture Sciences and Technology, Shalimar Campus, Srinagar - 191121

Many of the world's poor and low-income people lack affordable access to enough food and required nutrition to sustain their health and normal daily labour . The absolute number of food insecure people are growing annually, although at a global scale, the percentage of people living in poverty is shrinking. In 1993, 1.3 billion people were classified as "the absolute poor", and 800 million people as not having sufficient and regular supplies of food (World Bank Statistics, quote in Commission on Global Governance, 1995)

Aquaculture in India has evolved itself from the stage of a domestic activity to that of an industry over the years with some entrepreneurs undertaking the practices in a big way . The freshwater aquaculture sector with an estimated production of over 1.9 million metric tons of fish is contributing to the extent of 34% of the fish basket of the country (5.65 million mt in 1999-2000) with satisfactory growth of about 7.5% .

Operation Aqua-gold is proposed for doubling the fish production from freshwater sector in different states of the country with reference to varying agro-ecological conditions . Under this operation, it is proposed to increase the aquaculture area covereage to 11,99,500 ha from the present 8,26,230 ha with a mean productivity of 2,762 kg/ha/ yr that would yield 33,12,800 tonnes amounting to almost doubling of the present fish production. The strategy involves both horizontal and vertical expansion for achieving envisaged results. While most of the freshwater aquaculture is based on organic fertilization in the country, use of supplementary feed for increasing fish productivity with a few to realize the full potentials of the water is emphasized.

For enhancing fish production, increased area coverage with a emphasis on clearance of water from aquatic macrophytes, uniform long term leasing policies of waterbodies, intensification with due consideration to sustainability, need-based

Upland regions not adequately exploited so far should plan to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities. Fish farmers and their communities should be motivated for the development of responsible aquaculture. The use of chemical inputs in aquaculture which are hazardous to human health and environment need be regulated as per sustainability standards.

The hill fishery development has lagged behind within the inland sector . This is possibly due to the lack of adequate human resource development for such difficult terrain, since the existing fisheries colleges in the country are not in a position to cater to such national requirement. The action plan for high altitudes under open water fisheries will involve resources assessment, conservation by ranching, stocking of high mountain lakes, identifying areas for angling and tourism . Establishment of hatcheries of trouts, snowtrouts, and the mahseers, efforts to encourage/insist farms in private sector, creation of feed industry and marketing channels for transporting the produce from remote areas to main markets require urgent attention. Foothills are suitable for promotion of carp culture, fish-livestock farming and sustained efforts are warranted to create more culturable waters to enhance the resource base. Adequate Education, Research and Development in hill fisheries is very important . Uttaranchal, Jammu and Kashmir and Himachal Pradesh are the progressive hill states where a vast potential of water resources exist for judicious and scientific development of coldwater fisheries. The fishery resources in hill regions are comprised of fast flowing rivers and tributaries, natural lakes, springs, ponds, reservoirs. Theses waterbodies support a variety of fish species like snow-trouts, mahseers and common carp as well as many other locally preferred indigenous species.

The upland waters of India are world famous for their most prized game fishes like mahseers, trouts and Indian trout. The NBFGR has reported 73 typical upland fish species, forming 3.32% of the total 2200 species found countrywide which hold great potential for the economic development of hill regions through exploitation of aquatic and other available resources.

In order to ensure conservation and management of upland waters and fish germplasm, we need to check the deforestation and over-grazing activities along the sloppy catchments and go for afforestation of mixed and native plant species including variety of medicinal and aromatic plants for protection of such delicate/fragile ecosystems. The Indian Fisheries and Forest Acts also need revision with strict enforcement of

The people residing along the fragile catchments should be encouraged towards horticulture, livestock farming, aquaculture and other conservation oriented profitable integrated approach to occupations . All water-shed projects should include fish as an essential component since this is the only aquatic produce which does not consume water as is the case with other target group of products.

The aquatic resources and fish germplasm are our national wealth, which have co-evolved during the course of evolution. Any species getting extinct would upset the ecological balance resulting into dangerous imbalances in the system . Let us all join hands for protection and conservation of fish biodiversity in the country and make concerted efforts for sustainable use of our high altitude resources for national as well as regional self sufficiency.

COLD WATER FISHERIES - LOOKING AHED

S. Ayyappan and V.R.Chitranshi
Deputy Director General (Fy.) & Pr. Sci. (Fy.)

Indian Council of Agricultural Research,
New Delhi

Aquatic resources of hilly and mountainous region of the country are unique and endowed with a wide variety of stock of recreational and food fishes . This resource class has a special significance as it covers substantial areas in Himalayan region, which includes Greater Himalayas, Leasser Himalayas, Siwalik hills and peninsular uplands comprising Sahyadri; Nilgiris, Annalai and Cardamon hills. These two highlands have their own distinctive features due to wide variation in elevations ranging from about 600 m to 7000 m above sea level, climatic conditons and topographical features. Being health food , fish plays a vital role in meeting food and nutritional requirements for the people of the upland regions of the country. Coldwater fishing and aquaculture have great potentials for mitigating poverty and unempoyment in hill regions.

FISHERY RESOURCES OF HILLS AND MOUNTAINOUS REGIONS

The hilly and mountainous stretches of the Himalayan and peninsular uplands are gifted with rich, potential and wide variety of fishery resources in the form of torrential streams, rivulets, rivers, natural lakes both fresh water (Dal ,Wular, Anchar, Nainital, Sattal, Naukuchiatal, etc.) and salt water (Salt water lakes of Lingtzi Tang), deep pools, stagnant pools along with large, medium and small reserviors of various sizes and shapes . The production potentials of these ecosystems are extremely high and amelioration have special significance from development of fishery and amelioration of the economic condition of the people of the region.

ENDEMIC FISH FAUNA OF UPLAND WATERS

The unique ichthyodiversity of hilly and mountainous region is unmatched. The hill streams of Himalyan river systems namely Indus (Jhelum, Sutlej, Ravi, Chenab and Beas), Ganga (Bhagirathi, Alaknanda, Mandakini, Dhauli Ganga and Pinder) and Brahmaputra (Dihang, Lohit, Subansiri, Kenanga, Dhansiri, Manas, Champamati,

inhabiting upland waters are loaches (*Nemacheilus sp*), minor carps (*Labeo dero, Semiplotus sp, Crossocheilus sp, Garra gotyla gotyla*), barils and catfishes (*Glyptosternum reticulatum*). The exotic fishes that have been transplanted are salmonids, common carp and tench . In greater Himalayas and lesser Himalayas, schizothoracids and brown trout remain active even at very low temperature.

STATAUS OF LACUSTRINE RESOURCES

This productive resource base is persistently losing its biogenic production potential mainly due to unsustainable land use practices, waste and nutrient loading . Presently most of the natural freshwater lakes of Kashmir, Uttaranchal and north eastern states are chocked with many obnoxious aquatic weeds and their area is shrinking day by day . As a consequence of accumulation of silt, sediment , organic material and toxic chemicals at bottom the resource base has become uncongenial to support fishery. The ecodegradation problem is severe as a result these valuable resources are going out of productive use.

Presently most of the fishery resources in the hilly and mountainous regions are shrinking and losing their inherent biogenic potentialities and ichthyodiversity from escalating fishing pressure and physical and chemical modification of habitat. At present, out of 79 fish species categorized as endangered, vulnerable and rare in India, 17 species are from upland waters and hence protective measures are urgently needed to protect resource base as well as in ichthyodiversity.

DEVLOPEMENT OF FISHERIES IN HILLS AND MOUNTAINOUS REGION

Unlike plains, the development of fishery in hills and mountainous regions is a complex and tedious task due to multifacet problems, namely altitudinal variations (blow 1000 to 7000 m above msl), climatic variations, difficult terrain(rocks, boulders, stones, pebbles, sandy and muddy patches), isolation, inaccessiblity, small holdings and small pond size etc. Similarly, limited ecological niche, non availability of shelter and abundance of predators makes the habitat difficult and fish always remain under stressful conditions. The growth, survival and fish food organisms and wide variations and fluctuations in current pattern, transparency, temperature and oxygen levels. In greater Himalayas and lesser Himalayas, the fishes are exposed to very low temperatures even near freezing point and certain lakes remain frozen for major parts of the year. Most of the species are unable to withstand the sudden change in water temperature, therefore the incidence of fish kills is a common phenomenon in the upland region of the country.

of resource users, inadequate infrastructure for production and marketing alongwith non availability of trained manpower for development of fishery sector in the region .

FUTURE R&D STRATEGIES FOR ENHANCING FISH PRODUCTION

Keeping in view the changing scenario in the production potentialities of fishery resources of hilly and mountainous region, there is need for promoting ecologically sustainable management systems giving priority for the restoration of damaged ecosystems and rehabilitation of threatened and endangered species by ranching programmes . For ensuring sustainbility and long term sustainable use to be available fishery resources, following measures may be taken on a priority basis :

- A sound scientific data base on availability of resource and its ecological status from micro-level to macro-level for planning remunerative fishery activities in the region.
- Sound planning involving all R&D agencies along with resource users for scientific and sustainable utilization of aquatic resources available in the region .
- Conservation of resources and its ichthyodiversity by controlling destructive practices and promoting eco-friendly management norms.
- Identification and protection of spawning areas of commercially important fish species in different stretches .

For fish enhancement in the region, there is need to take up aquaculture programme in small ponds, natural lakes and reservoirs . The seasonal ponds scattered in large tract may be effectively used for getting short term fish crop of 3-6 months duration. Similarly for development of fishery in natural lakes and reservoirs cage culture technology may be adopted . Other activities which need attention are :-

- Demonstration of seed production technology, rearing management and growout technology of economically important game and food fishes to the resource users .
- Establishment of disease diagnostic facilities at suitable zones .
- Development of infrastructure facilities like setting of hatcheries, fish feed plants and fish processing centers .
- Strengthening of market structure including storage facilities, ice plants, cold chains to ensure higher profit margin to the producers .
- Post-harvest technology measures like processing and value addition to make the sector more attractive to the investors .
- Skill oriented training programmes relating of fisheries management, seed production and grow out system for fishermen, aquafarmers and enterpreneurs.
- Institutional financial support.

By sound planning, use of scientific management system, eco-friendly production technology the current production trend in the hilly and mountainous region can be

A - HILL AQUACULTURE

A-1

AQUATIC BIODIVERSITY RESTORATION PROGRAMME IN TARAI REGION OF WEST BENGAL THROUGH INDUCED BREEDING AND PROPER EXTENSION METHODS

Madhumita Mukherjee, R. Fonnin Lepcha and Atul Biswas

Office of the Deputy Director of Fisheries (M & P),
Government of West Bengal,
Captain Bhery, E. M. Bypass, Kolkata-700 039

In the Terai region (North Bengal) located on the foothills of the Himalayas extending over Jalpaiguri and to some extent of Darjeeling district (Siliguri), 39 critically endangered fish species have been identified till date. These species are under constant threat due to the use of as many as 92 marketed brands of insecticides/pesticides, which are being continuously used in the agricultural sector. Some very well known species are Chital (*Notopterus chitala*), Kursa (*Labeo gonius*), Saran punti (*Puntius sarana*), Raikhar (*Labeo reba*) and Mahseer (*Tor putitora*). Among the other threats existing in this region are the construction of hydroelectric dam across the river Tista, indiscriminate and wanton killing of fishes in river Tista by use of nets, poison, dynamite etc. besides the siltation of rivers of North Bengal due to rampant deforestation.

For restoring biodiversity in this region, Dept. of Fisheries has already undertaken several breeding programmes of the endangered species mentioned above. Experiments on cryopreservation of the sperm of these species have also been initiated.

A-2

FIRST INDUCED BREEDING EXPERIMENT ON GARHWAL HIMALAYAN SNOW-TROUT *SCHIZOTHORAX RICHARDSON II* (GRAY) BY HYPOPHYSATION AND STRIPPING TECHNIQUE

S.N. Bahuguna and Madhu Nautiyal

Histo-chemistry, Biochemistry & Fish breeding Lab;
Department of Zoology (UGC-SAP), HNB Garhwal University,
Srinagar, P.B. No. 70, Garhwal-246 174 (Uttaranchal)

The study was conducted to have a fair idea of the fish culture evaluation in Garhwal hills and to determine the optimum dose of pituitary gland extract (PGE) for spawning of the snow-trout, *Schizothorax richardsonii*. The dose of PGE given to male fish was @ 5 mg/kg fish weight while in female, it was 7 mg/kg in two split doses. The artificial fertilization was also done by stripping the mature brooders which gave better results.

Fecundity in *S. richardsonii* was recorded from 5,200 to 13,542. Fertilization and hatching ranged from 63.26 to 85.2% and 51.38 to 72.6%, respectively.

A-3

FISH CULTURE AS MEANS OF SPORT AND FOOD FOR THE ARMED FORCES

Ashok Kumar and Narendera Kumar

Defence Agricultural Research Laboratory,
Govt. of India, Pithoragarh -262 501 (Uttaranchal)

Our Armed forces symbolize advancement and holds no barred attitude when in action either defending the frontiers or developing cantonments. Along with many extracurricular activities inside campus, fish culture has also been adapted with great strides as a scope of sport and food by our armed forces. Eight assorted ponds comprising 1.5 ha area in the cantonment of Pithoragarh, two ponds of 0.2 ha area at GRTU Raiwala and two ponds with 0.1 ha area at Joshimath are under fish culture. The ponds at Pithoragarh are a part of the sport ground (Golf) while at Raiwala and Joshimath, they are for training and demonstration activities to the superannuating and active Jawans. Exotic carps like *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella* and *Cyprinus carpio* are being cultured under the technical guidance of the scientists of Defence Research & Development Organization (DRDO). Further steps are proposed for a giant leap to forward the arena of sport fishery, culture fishery and dissemination of technology.

A-4

IDENTIFICATION OF PRODUCTIVITY LIMITING SOIL FACTORS FOR FISH PONDS UNDER FOOT HILL AREAS OF WEST BENGAL

*U.Nath,** Amrita Thakur,* Abira Banerjee * Madhumita Mukherjee,** and G.N. Chattopadhyay**

***Soil Testing Laboratory,Institute of Agriculture, Visva-Bharati, Sriniketan-731236**
**** Dept. of Fisheries, Govt. of West Bengal Captain's Bheri, Kolkata- 700 039**

Inspite of widely accepted importance of bottom soil in determining productivity of fish ponds, little attention is usually paid to understand the nature and properties of such soils while managing productivity of an aquaculture system. Foot hill soils constitute a major soil group in West Bengal occupying about 6.48 lakh ha covering three districts of the state. Productivity levels of fish ponds under this soil zone are of considerably lower order in comparison to average fish production values of the state. Although such low productivity has been apparently attributed to the occurrence of adverse soil properties under this soil zone, yet no effort has been made so far to study this aspect in detail and to identify the specific soil related constraints responsible for poor productivity of the fish ponds situated under this soil zone. In the present investigation, an attempt was made to study the properties of fish ponds soil under foot hill areas of West Bengal, to correlate the properties with primary productivity levels of the ponds and to identify the major soil factors related with productivity of such ponds. The study will provide valuable information for management of fish ponds situated under these foot hill areas and will help to improve their productivity.

A-5

SOYA BASED AQUA FEED: A COST EFFECTIVE AND GROWTH PROMOTING FEED FOR MAHSEER

*Anukriti Shrivastava and Praveen Tamot**

Dept. of Applied Aquaculture, Barkatullah University, Bhopal
*** M.P.Council of Science & Technology, Bhopal**
Vigyan Bhawan, MACT Campus, Nehru Nagar, Bhopal

Aquaculture has extremely rapid expansion during last few years. In coldwater fishery sector, more emphasis is given on the conservation of mahseer which is an endangered species. It requires high protein feeds for economical growth rate under intensive culture conditions. The limited supply and high cost of fishmeal has encouraged to consider the alternative sources. High vegetable protein concentrates in fish diets generally result in low growth rates and poor feed efficiency ratio due to imbalance in essential nutrients, raw material antinutritional factors and low palatability.

Soyameal/okara (residue obtained from the Soya milk industry) are efficiently used due to its chemical composition, amino acid profile and high availability around the world at low prices. Dehulled solvent extracted soymeal contains 48.4% protein (85% digestible), 5.3% fat, 6.5% fibre, 6.8% mineral matter and 33.0% N-free extract.

Mahseers (*Tor* spp.) have been the legendary sport fish in India with high table value. As a food, mahseer fish was cultured for over 126 days, employing the above types of pelleted feeds procured from various sources to assess the influence of these diets on its growth. The diet containing soymeal induced best growth followed by rice bran and least in subabul leaf powder.

A-6

STATUS OF AQUACULTURE IN KUMAUN HILLS

S. S Pathani

Department of Zoology,
Kumaun University, S. S. J. Campus, Almora 263601(Uttaranchal)

Survey of ichthyofouna in the Kumaun Himalaya have recorded 7 families, 23 genera and 40 species including 3 exotic and 3 Indian major carps in the waters. Out of 40 species, the economically viable fishes - mahseers *(Tor tor ,Tor putitora),* snow-trouts (*Schizothorax richardonii, S. plagiostomus), Mastacembelus aramatus, Labeo dero, L. dyocheilus, Barilius bendelisis, B. bola, Garra gotyla, Catla catla, Cirrhinus mrigala* and *Labeo rohita, Cyprinus carpio*(3 varities) *Ctenopharyngodon idella,* and *Hypophthalmichthys molitrix* are available in the lentic and lotic waters of Kumaun Himalaya. Exotic mirror carp is cultured commonly for last 20 years while silver and grass carps are, of late, being cultured with common carp in some small/mini village ponds in the region.

The annual and daily catch of different water bodies is made partly by State Fishery Department at Bhimtal and partly by unorganized fishermen in the lotic waters. The annual fish catch data shows a poor fish catch ranging from 5.2 to 10.9 kg , 0.37 to 3.20 kg. and 3.0 to 17.80 kg with a mean value of 8.74 kg ,10.44 kg and 1.124 kg per ha in Bhimtal, Sat tal and Naukuchiatal lakes respectively during 1984-1992. It also indicates that the fish production is declining in Kumaun lakes because the highest fish catch was 21.54 quintals in 1975 and the lowest 5.389 quintals in 1978. The average fish catch during 1991-2000 was 9.058 quintals but it was 10.967 quintals during 1981-1990 in Kumaun lakes. Further, the total fish production by gill netting indicates low fish catch which ranged from 1.959 to 3.44 kg per day in Kumaun lakes during 1984 to 1995 while it ranged from 8.10 - 80.80 kg per day by angling methods in breeding season during 1975-1980. On the annual basis, fish catch ranged from 50 to 150 quintals with a mean value of 89.56 quintals in Saryu river during 1991-2000 while from 23 to 45 quintals with a mean value of 27.123 quintals in Ramganga west during 1996-2000. The fishing season ranged from March to August and very low or occasional fishing was recorded from October to December in the lotic waters. Various measures to increase fish production for commercialization of aquaculture in future have been

A-7

FACTORS AFFECTING MYCOSES IN SMALL FISH POND

Deepa Bisht

Biotechnology complex
G.B. Pant Institute of Himalayan Environment & Development,
Kosi-Katarmal, Almora - 263 643 (Uttaranchal)

Mycoses are a common fish disease caused by watermolds from the class Oomycetes that are a constant and ubiquitous component of aquatic environment. Several species of watermolds, particularly those belonging to *Achlya, Aphanomyces* and *Saprolegnia* parasitize eggs, fry, fingerlings and adult fish. Aquatic resources of Kumaon region provide great scope for fresh water fishery. During 2001-2002, four small ponds were constructed in Almora and Bageshwar districts and fingerlings of chinese carp species *i.e., Cyprinus carpio* var *communis* (common carp), *Hypophthalmichthys molitrix* (silver carp) and *Ctenopharyngodon idella* (grass carp) were introduced. High mortality of fingerlings was observed in silver carp and grass carp exhibiting symptoms as dry skin, sunken eyes and skin lesions accompanied by whitish cotton patches over skin. Two species of zoosporic fungi *viz., Saprolegnia diclina* and *S. parasitica* were isolated from a large number of symptomatic fingerlings. Species of host showed differential immunity, chinese carp being more susceptible. Fungal infection started during the first week of February in both the fish species and by the middle of March, disease incidence in different ponds ranged between 32.5-45.0% to 25.0-30.0% in silver and grass carp, respectively. Disease did not progress further and was suppressed from May onwards. A moderate water temperature of 22-25°C coupled with pH 7.0-7.9 and dissolved oxygen 7.5-9.0 mgl-1 were found congenial for the development of disease, as highest incidence of mycoses coincided with temperature, pH and DO within this range. High temperature (>28°C) retarded the disease development. Besides, previous exposure to significant stress during transport from hatchery, physical injury, pre-existing illness may predispose fish to fungal infection.

Results also indicate that the occurrence of mycoses depend on two major factors : i) a rapid drop in water temperature during winter which reduces immunity

A-8

PRESENT STATUS OF THAI MAGUR (*CLARIAS GARIEPINUS*) FISHERY IN JABALPUR DISTRICT (M.P.)

Praveen Ojha and A.K. Mandloi

Department of Fisheries, J.N. Krishi Vishwa Vidyalaya, Jabalpur - 482 004 (M.P.)

In the recent years, carp farming in Jabalpur and adjoining villages received threat as more and more of farmers and some new entrepreneurs have started culturing of Thai magur. Fish farmers provide supplementary feeds as waste from slaughter houses and hotels etc. It has been reported that the growth of Thai magur is 400 to 500 g in 3-4 months with good survival rate. Few farmers have reported 500 to 750 g within 3-4 months. Growth of Thai magur is totally dependent upon the availability of natural as well as supplementary feeds.

In a preliminary survey of Jabalpur market, Thai magur covers more than 50% of total fish market in monsoon period and more than 20% of total fish market, in rest of the period. Since production cost of this species is not much, so the producers and fish sellers are getting huge profit. It is getting popular, inspite of the fact that Govt. of India has banned the culture of Thai Magur. Thai magur seed are brought from Kolkata market (W.B.) @ of 10-25 paise per piece. The fish is sold @ Rs. 40-55/kg in normal month and @ Rs. 70-80/kg in monsoon months. This has resulted in an adverse effect on culture and marketing of indigenous carps. It is therefore suggested that the State Government should take appropriate and corrective measures to save the native fish fauna and discourage the fish farmers to culture the highly damaging and dangerous fish i.e. *Clarias gariepinus* (Thai magur).

A-9

CAGE CULTURE OF MAHSEER, *TOR KHUDREE* (SYKES) AND *TOR PUTITORA* (HAM.) AT WALWAN RESERVOIR, LONAVLA, DISTRICT PUNE, MAHARSHTRA

M.P. Singh Kohli, S. Ayyappan, R.K. Langer, S.N. Ogale, Kiran Dube, Chandra Prakash and A.K. Reddy*

Central Institute of Fisheries Education , Versova, Andheri (West) Mumbai-400061

Culture of *Tor khudree* and *Tor putitora* was conducted in cages at Walwan reservoir, Distt. Pune, Maharashtra. Cages used for the experiment were fabricated with strong material and provided with working platform. Each cage was made of HDPE net having a dimension of 3m x 3m x 3m with a mesh size of 15 mm. Cages were suspended in angle iron frame provided with sealed drums as floats. Cages were stocked with *Tor khudree* having an average length of 161.38 mm and average weight of 35.20 g and *Tor putitora* having an average length of 120.71 mm and average weight of 14.60 g. Stocking was done at 50 nos/m^2. The fish were fed twice a day @ 5-10% body weight with formulated feed containing fish meal 5.0%, Acetes 10%, GOC 35%, wheat bran 35.0%,wheat flour 11.5%,vegetable oil 2.5% and vitamin mix 1.0%.

Experiment lasted for 371 days for *Tor khudree* and 356 days for *Tor putitora* with a harvesting length and weight of 288.07 mm, 285.16 g and 223.85 mm and 206.45 g respectively, with an average growth of 0.68 g and 0.54 g per day, a survival rate of 46.30 % and 68.89% and a feed conversion of 1:3.9 and 1:4.76 respectively.

A-10

ISOZYME (S) PATTERNS FOR CHARACTERIZATION OF FARM REARED INDIAN MAJOR CARPS

Hema Kothari, Rajeev Kapila, A.K. Gaur and Rakesh Mall*

Department of Biochemistry, College of Basic Sciences and Humanities, G.B. Pant University of Agriculture and Technology, Pantnagar-263 145, Uttaranchal

***National Research Centre on Coldwater Fisheries, Bhimtal - 263 136 (Uttaranchal)**

Many fish populations are presently undergoing drastic fluctuations in size and distribution. There are evidences of decline of population of Indian major carps. Thus the present pressing circumstances demand proper management and efficient conservation. The study was conducted using protein(s) based electrophoretic markers especially the isozymes and some non- enzymatic proteins which can be used as parameters in the acquisition of a comprehensive knowledge regarding the interpopulational relationships and divergence of fishes in general. Three enzymes *viz.*, MDH, LDH and Malic enzyme were visualized on native PAGE. In muscle samples, LDH showed two coding loci in *C. catla* and *C. mrigala* and only one in *L. rohita* while in liver , it had exhibited three coding loci in *C. catla* , and *L. rohita* and four in *C. mrigala*. While MDH expressed two coding loci in muscle of all three fish species and liver of *L. rohita* and *C. mrigala* but in *C.catla* , there was only one loci. Malic enzyme revealed two loci in muscle and liver of *C. catla* and *L. rohita* and three loci in both tissues of *C. mrigala*.

Except differences in number of coding loci for LDH in muscle of *L. rohita* and liver of *C. mrigala* and for MDH in *C. catla* liver and malic enzyme in liver and muscle of *C. mrigala*, the pattern of coding loci in all 3 species for the three enzyme systems expressed in similar fashion which again revealed similarity between these fishes to a greater extent but observation of differences might be correlated with their status as different species belonging to the same family.

Since no polymorphism was observed for any of the three enzymes studied in

A-11

PERFORMANCE OF DIFFERENT FEEDS ON GROWTH OF JUVENILE SNOW TROUT, *SCHIZOTHORAX RICHARDSONII* (GRAY) IN SHIWALIK HIMALAYAS

M. Mohan, Y. Basade and S.K. Bhanja *

National Research Centre on Coldwater Fisheries,
Bhimtal - 263 136 (Uttaranchal)
***Central Avian Research Institute, Izatnagar (U.P)**

Snow trout, *Schizothorax richardsonii* (Gray) prevalent in entire Himalayan belt serves as an important component of subsistence fishery and constitutes more than 70% of total riverine fisheries. The fish is relished from northwest region of himalayas to extreme eastern region. Food and feeding of this species has been studied and attempts to breed, culture and maintain the brood stock have also been attempted. The present study deals with experiments conducted on performance of different feeds namely, NRCCWF-I, NRCCWF-II and NRCCWF-III prepared in the laboratory with different feed ingredients. The net weight gain, percent weight gain, specific growth rate, feed conversion ratio, feed conversion efficiency and survival did not exhibit any significant difference among NRCCWF-I and NRCCWF-II feeds and also among the fish fed with NRCCWF-II and NRCCWF-III feeds. However, the cost of NRCCWF-III feed was the lowest suggesting that NRCCWF-III feed is advantageous over NRCCWF-I and NRCCWF-II feeds. The results obtained so far will facilitate future research workers to improvise these diets for hitherto slow growing snow trout species.

A-12

GROWTH PERFORMANCE AND CONVERSION EFFICIENCY OF RAINBOW TROUT *ONCORHYNCHUS MYKISS* (WALBUM) FED WITH PELLETED DIET AT DIFFERENT RATES

K.D.Joshi, H.S.Raina and K.K.Vass*

National Research Centre on Coldwater Fisheries, Bhimtal -263 136, Distt. Nainital (Uttaranchal)
***National Research Centre on Coldwater Fisheries, Champawat (Uttaranchal)**

The growth performance and profitability of a trout fully depends on the quality and quantity of feed provided to the stock as per their body requirement. In general, the feed requirement of rainbow trout (*Oncorhynchus mykiss)* is considered optimum and economically viable between 3.0-5.0 % of body weight for fry whereas 0.75-1.0 % for adults. A short- term experiment for 30-days during September 2000 was conducted to ascertain the growth parameters of Norwegian rainbow trout *(Oncorhynchus mykiss)* fed with formulated feed at different rates in climatic conditions of Champawat farm in Central Himalayan region. The study was conducted at Experimental Fish farm Chhirapani, Champawat, located at an altitude of 1620 m asl. Rainbow trout of 1+ year in age and 100-104 g. average weight were stocked in nursery ponds (10.0 x 3.0x 1.25 m). The stocking density was maintained @ 5 fish/m^2 in all ponds. The formulated feed pellets of known composition were fed to the trout stocked in different ponds @1, 2 and 3 % of the body weight. The growth rate was recorded as 0.93, 1.8, 2.6 g /day with corresponding FCR values of 1.07, 1.11 and 1.20, respectively. The range of water flow, water temperature, dissolved oxygen and free carbon dioxide in the ponds varied between 40-50 l/mt, 17.0-20.5^0 C, 7.2-8.0 mg/l and 1.2-2.0 mg/l during the period. All the details about husbandry practices. feed, feeding, growth parameters, survivability and conversion efficiency are discussed in the paper.

A-13

REHABILITATION OF GOLDEN MAHSEER *TOR PUTITORA* (HAM.) THROUGH LARGE - SCALE SEED PRODUCTION

M. Mohan and R.S. Haldar

National Research Centre on Coldwater Fisheries, Bhimtal- 263 136, Distt. Nainital (Uttaranchal)

The rehabilitation of golden mahseer, *Tor putitora* (Ham.) rests on two complementary approaches. The first is effective conservation of stocks for the augmentation of depleted resources and second can be stocking natural water bodies with fry/fingerlings. Conservation, though quite effective, is a long-term process and involves formulation and implementation of strict legislative and voluntary protection measures.

The better and most effective process of rehabilitation of golden mahseer is the stocking of water bodies, which involves large-scale seed production of mahseer through hatcheries. The artificial propagation of this species initiated in late seventies has been further developed and perfected at National Research Centre on Coldwater Fisheries, Bhimtal. It was thought that seed production unit of golden mahseer should be very simple which can meet the requirements of far remote areas of himalayan terrain and may be designed to serve as transferable, dismantling type.

Keeping it in view, a flow- through hatchery was developed which works on the principle of lifting of water from nearby stream and its distribution in various components of the hatchery that has proved to be very efficient in utilization even during the limited water supply.

During one decade, about a million seed of golden mahseer has been produced at Bhimtal hatchery that has been stocked in various lakes in Nainital district and rivers in Almora district of Kumaon Himalayas under the ranching and rehabilitation programme. The seed of this important germplasm has also been provided to other user agencies such as various State Fisheries Departments, State Agricultural Universities, Defence

A-14

SEASONAL POPULATION DYNAMICS OF BACTERIA AND THEIR RELATIONSHIP WITH ABIOTIC AND BIOTIC FACTORS OF A SUBTROPICAL FISH POND

J.P. Sharma and V.K. Gupta

Rural Development Unit, Regional Research Laboratory (CSIR), Jammu Tawi - 180 001

During the present investigations, the seasonal fluctuations of bacterial populations, zooplankton, phytoplankton and physico-chemical factors were recorded from a fish pond so as to evaluate their intrinsic relationships. Zooplankton showed a bi-model pattern during the period of study but no such pattern was recorded in bacterial counts. Aerobic and facultative bacteria (SPC cfu /ml) however, showed a positive relationship with phytoplankton and negative relationship with zooplankton population. Temperature showed a significant relationship with aerobic facultative bacteria and also with the coliform count (MPN/ 100 ml). The total bacterial count (TBC/ ml) recorded to be maximum (8.24×10^{11}/ ml) at higher temperature in the month of June and minimum (3.68×10^{6}/ ml) at lower temperature in December indicating a positive relationship.

The facultative aerobic bacteria SPC / ml was found to be minimum (180 cfu / ml) in January and maximum (472 cfu / ml) in the month of June. Standard plate count (SPC/ ml) also showed a positive relationship with dissolved oxygen and dissolved organic matter (DOM) and found to be maximum (472 cfu / ml) during the period of higher dissolved oxygen (14.4 ppm) and dissolved organic matter (20.2 ppm). The maximum zooplankton (1254/ l) were recorded during the period of minimum facultative aerobes (182 cfu / ml) showing a negative relationship. Phytoplankton however, showed an increase from January, maximum (8×10^{3}/l) being in the month of June when standard plate count was found to be maximum (472 cfu/ml), thus showed a positive relationship. Details are discussed in the paper.

A-15

SOME ASPECTS OF REPRODUCTIVE BIOLOGY OF *LABEO DYOCHEILUS* (McCLELLAND)

I. J. Singh, Anup Kumar, K.S. Mehta and U.P. Singh

College of Fishery Sciences,
G. B. Pant University of Agriculture & Technology, Pantnagar

The fish, *Labeo dyochelius,* known as Kali rohu or Khat in hilly parts of the Uttaranchal, constitute an important fishery of different river systems of the state like Kosi, Ramganga, Ganga etc. The patterns of gonadal development of *L. dyocheilus* in its natural habitat and under captive conditions at our instructional fish farm and response of this fish to inducing agents for successful induced spawning under captivity embody the part of present study being presented here. On the basis of gonadosomatic index and observations of gondas, it was found that gonadal development in fish reared under captivity was advanced in the end of May compared to the specimens collected at the same time from Ramganga river. However, the factors responsible for early gonadal maturation under captivity are not possible to be delineated on the basis of presently available data but possibly nutritional status or temperature or both could have played the decisive role. The acclimatization of broodstock of *L. dyocheilus* in comparatively cooler water for 4-6 hours prior to injection of ovaprim had resulted in more easily oozing out milt from males and gave better fertilization percentage. The induced breeding trials indicated that overall induced breeding of this fish after induction by ovaprim was not very successful in traditional hapa system. However, at the same dose level of ovaprim in flowthrough hatchery system the sapawning had taken place very effectively. Successful dose level for male was 0.4 ml / kg body weight and for female specimens, it was 0.6 ml / kg body weght. The size of fertilized and full swollen eggs varied from 4 to 5 mm and hatching took place within 15 to 17 hours. The males used for induction of spawing in July were again able to produce sufficient amount of viable milt one month later in August after induction by ovaprim. Above aspects of reproductive biology of *L. dyocheilus* will be discussed in detail.

A-16

COMPLETE LARVAL DEVELOPMENT OF THE COLDWATER PRAWN OF KUMAUN HIMALAYAS *(MACROBRACHIUM ASSAMENSIS PENINSULARIS)* (DECAPODA, PALAEMONIDAE) REARED IN THE LABROTARY

S. Kumar and H.C.S. Bisht

Department of Zoology, Kumaun Univeristy, D.S.B. Campus, Nainital

Macrobrachium assamensis peninsularis is a minor prawn which is widely distributed in the rivers and streams of Kumaun himalayas. In vernacular language, this prawn is called "Jhaun maach". Size-wise and availability-wise, it is well comoparable with the other exploitable species of smaller prawns found in the country and therefore, is considered to be an important local food resource. Presently there is no organized fishing of *M. assamensis peninsularis* in Kumaun of this prawn. However, in certain areas, where this species is found in abundance, it is regularly caught and consumed as a food item. But because such fishings are generally untimely and indiscriminate, they are rather harmful and are causing fast depletion of this natural food resource. This situation warrants the culture of the concerned species on commercial scale. With this idea in mind, attempts were made to raise the seed of *M. assamensis peninsularis* under laboratory conditions. The characteristics of the larvae and juveniles of this prawn have been studied minutely from the seed identification point of view.

For larval development studies, female prawns were maintaine4d in dechlorinated water in glass aquaria of 50 l capacity with continuous aeration and thermostatically regulated water temperature. The prawns were given algae and fish meal as food which they consumed *ad libitum*. At a water temperature of 25 $\pm$ 3°C, the freshly oviposited prawns took 25-32 days for their brood to hatch. No hatching occured below the temperature of 20°C. The developmental stages included Larva I, Larva II (which are advanced zoeal forms), a postlarva and juvenile, started from the stage of postlarva which became benthotrophic . Other characteristics of the larval stages are :

pleopod with very small endopod. Others with just - formed appendix interna. Tail fin is posteriorly broad, the uropod bud faintly showing through it but telson and functional uriopods yet to be differentiated.

Larva II : It is 6.0 ± 0.18 mm in length. Rostrum longer, straightened and has seven dorsal and two ventral teeth. In antennule, statocystic area is demarcated. The incisor process of the mandible with a very small conical tooth. Uropod bud faintly divided.

Postlarva : It is 6.2 ± 0.18 mm in length. The rostrum overreaches the antennular peduncle. The last dorsal tooth very distinct and precisely postorbital in position. The orbital notch of carapace has widened ventrally. Eyestalk becomes narrow and is separated from orbital notch. In antennule, the statocyst has been formad. Mandibular palp devloped. Inncisor process with two teeth . Molar process indented. The tail fan is differentiated into a pair of biramous functional uropods and telson.

Juvenile: It is initially 6.5 ± 0.26 mm in length. The general appearance is similar to that of abult. Eyestalks become movable. The post-antennae and hepatic spines are seen on the carapace. Mandibular palp is well formed and teeth appear on molar process as well. The telson narrows, shows two pairs of short spines posterodorsally.

In comparison to the larval developemt as seen in the large prawns like *M. carcinus, M. acanthurus* and *M. malcolmsonii* in which there are several free swimming larval developement in *M. assamensis peninsularis* is of totally abbreviated type and is characterized by minimum number of larval stages which are never free swimming. This condition is of definite advantage in prawn culture because it will be easier to collect the seed in this case and the chances of the seed being devoured by other animals shall be less.

A-17

SURVIVAL AND REPRODUCTION STUDIES ON *MACROBRACHIUM ASSAMENSIS PENINSULARIS* (DECAPODA, PALAEMONIDAE) IN RELATION TO SOME ECOLOGICAL PARAMETERS

H.C.S. Bisht and S. Kumar

Department of Zoology, Kumaun University, D. S. B. Campus, Nainital

Macrobrachium assammensis peninsularis is a coldwater prawn of smaller size but its potential for culture in the upland waters of Kumaun Himalayas has been recognized. Therefore, the influence of variations in some ecological factors viz, water temperature, pH and dissolved oxygen on the survival of the adults, juveniles and postlarvae of this prawn has been studied. The effects of temperature, pH and the availability of food (or starvation) on the reproductive performance of the same prawn have also been examined . This information is significant from the culture point of view.

In the temperature range of 10-30^{0}C, there was no mortality in the adults and juveniles as well as the adults showed various degrees of mortality and there was no survival after 12 hr at 40^{0}C and 36^0 of temperatures. The postlarvae showed mortalities at temperatures below 14^{0}C. Recovery experiments have shown that the adults have a better capacity to recover from hyperthermic stress than the hypothermic stress.

The adults and the juveniles tolerated pH variations between 6.75 and 9.0 with almost no mortalities upto 48 hr. There was no survival after a 12 hr exposure to pH 5.0 and 9.75. The toleration range with no mortality for the postlarvae was found to be very narrow *i.e.*, pH 6.75 to 8.25. 100% recovery in the adults was recorded after 48 hr exposure to the pH of 9.25 only.

As for the tolerance to dissolved oxygen variations, none of the stages of the prawn survived without mortality at and below the dissolved oxygen (DO) concentration of 3.5 mg/l. At the concentration of 2.5 mg/l, whereas the adults and the juveniles experienced 100% mortality within 8 hr, the postlarvae exhibited only 90% mortality after the same period of exposure . The recovery upto 48 hr was 100% after exposure

20 days. The gonadosomatic index (GSI) of female prawns was found to have increased in relation to temperature but the HSI showed a decreasing trend with increasing temperature or increasing GSI . The changes in the gonads and hepatopancreas of male prawns followed the same trend as observed in females but the differences were significant between 15°C and 28°C only.

The pH levels tested were 6.75, 7.25 and 8.0. The GSI of female as well as the male prawns was maximum after maintaining the animals at the pH of 7.25 though the values were significant only in female subjects. The HSI on the other hand exhibited a decreasing trend in comparison to the values obtained at pH 6.75.

The results of the present experiments show that all the tested parameters have a definite influence on the survival and reproductive performance of *M. assamensis peninsularis*.

A-18

ROLE OF HORMONCES AND SEMI-BLANANCED DIETS FOR ADVANCED AND MULTIPLE MATURATION, BREEDING AND SEED PRODUCTION OF THE INDIAN CATFISH, *HETEROPNEUSTES FOSSILIS* (BLOCH)

B.N. Singsh, A.K. Pandey, Guddy Kanungo and Monika Sarkar*

Fish physiology Division, Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar - 751 002
*** Indian Council of Agriculture Research, Krishi Anusandhan Bhawan II, IARI Campus, Pusa, New Delhi - 110012**

The freshwater catfish, *Heteropneustes fossilis*, commonly known as "Singhi" in many parts of India is a cultivable species of high consumer preference. This is an air breathing fish having high haemoglobin content (11.58%) and can live out of water for several hours if the skin is kept moist. This catfish attains maturity in the second year of life and breeds once in a year during monsoon season . The annual reproductive cycle of the fish is divisible into four periods : (i) preparatory period (February-April), (ii) pre-spawning period (May-June), (iii) spawning period (July-August) and (iv) post-spawning period (September-January). In order to document the role of hormones and semi-balanced diets for advanced and multiple maturation, breeding and seed production of the Indian catfish, *Heteropneustes fossilis*, experiments were conducted both under hatchery and pond conditions. Oral as well as intramuscular (im) administration of human chorionic gonadotropin (HCG) in the doses of 25 and 50 IU/kg body weight/ week from mid-February onwards advanced maturity by April/May whereas the control fishes attained maturity during end of June/early July. Similarly the catfish maintained on the semi-balanced diet (size 2 mm pelleted @ 3-4 % of body weight once daily) consisting of fish meal 30% groundnut oil-cake (GOC) 25%, soybean oil-cake (SOC) 20%, wheat flour 10%, rice bran 14.8%, trace mineral mix 0.1%, and vitamin mix 0.1% (crude protein 34-35%; gross energy 4200-4300 kcal/kg) displayed gonadal maturity by April end whereas those fed with conventional diet comprising groundnut oilcake (GOC) and rice bran (50:50) matured by June/early July . Fishes were bred successfully with ovaprim at the dose of 0.5-0.8 ml/kg for females and 0.2-0.4 ml/kg for males . Females

A-19

EVALUATION OF INDIGENOUS AND ALIEN INVASIVE FISH SPECIES IN AQUACULTURE SYSTEMS IN HILLS

B.C. Tyagi

NRC on Coldwater Fisheries, Bhimtal- 263136

The fish species known to perform better in terms of growth, survival, maturation and breeding under cultivation are the first choice to be included in aquaculture systems. Among the reported 257 fish species from Indian coldwaters, only Indian snow- trout (*Schizothorax* spp. - *2*), mahseer group (*Tor* spp.-*5* and *Neolissocheilus hexagonolepis)* and Indian trout (*Barlius* spp. - 4) are commercially important in the catches from open waters.None of them could attain the status of cultivable fish species of coldwater because of extremely slow growth rates, narrow thermal regime and technological support. Instead of developing the techniques for their culture to conserve and enrich their population, the fish species performing well elsewhere were introduced / transplanted directly into lakes and rivers in the hills. Initially, exotic trouts (9 species), doctor fish (*Tinca tinca),* golden carp (*Carassius carassius),* larvicidal fish (*Gambusia affinis)* and three phenotypes of common carp (*Cyprinus carpio)* were introduced without evaluating their performance in coldwaters. Subsequently, impressed from their performance in warm water aquaculture, the Chinese carps namely *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella* got entry into coldwaters. Indian major carps were also transplanted in coldwater lakes with limited succes.

The results are of mixed nature. The Chinese carps, rainbow and brown trouts and *Gambusia affinis* have demonstrated their ability to establish in natural waters and became commercial coldwater species biting the share of indigenous commercial species. Most of the studies conducted on fish and fisheries of coldwater lakes in India squarely blamed exotic species for the loss of indigenous fauna in their number and size . On the other hand, exotic rainbow trout and Chinese carps are performing well in pond culture system under varied husbandry practices in Northeast, North-West Bengal, H.P., and Uttaranchal.

To evaluate the performance of the most important indigenous (*Schizothorax richardsonii, Tor putitora,* Indian major carps) and alien invasive fish species

husbandry practices. The growth data on 'Katli' *Neolissocheilus hexagonolepsis* and 'Kali rohu', *Labeo dyocheilus* were collected and compared. The grass carp, silver carp, comman carp and 'Katli' have emerged as most suitable species for developing aquaculture system in the hills. Himalayan and Deccan mahseers, next to these species of commercial importance, at present, need biotechnological manipulation to upgrade them for aquaculture. The technology based on indigenous and alien species hold promise to enhance fish yield and farm income of the people in the hills.

A-20

PERSPECTIVES FOR THE DEVELOPMENT OF FISHERIES AND AQUACULTURE IN UTTARANCHAL

A. P. Sharma and Archana

Department of Fishery Hydrography, College of Fishery Sciences, G. B. Pant Univ. of Ag. & Tech., Pantnagar, Uttaranchal .

Encompassing over an area of 53204 km^2, Uttaranchal, the newly carved Hill State in Central Himalaya abounds in aquatic resources in the form of rivers (2700 km), lakes (297 ha), reservoirs (18931 ha) and ponds (>600 ha). The region has diversified geography with wide altitudinal variations and varying climates ranging from tropical to hot and humid to subtropical, tropical, temperate and cold temperate. Owing to vast climatic variations, the fish fauna is highly variable being represented by more than 80 species. The main fisheries is constituted by major carps in plains and river valleys, snow trouts and mahseer in high altitude waters and exotic trouts in cold temperate waters. Besides, the natural waters also support fishery of medium sized carps *viz.*, *Labeo dyocheilus* and *Labeo dero* in the valley and sub-tropical zones. A large number of small sized fishes like *Barilius*, *Garra*, *Noemacheilus*, *Botia* etc. constitute a major component of high altitude fisheries in the natural waters. However, the capture fisheries of Uttaranchal has greatly dwindled in the past two decades due to various detrimental methods of fishing, mass killing of natural habitats, destruction of brooders, introduction of exotics etc. The population of mahseer, the mighty sport and food fish of the Central Himalaya has greatly declined so much so that it has been declared as endangered species. The population of snow-trout, which occurs in all streams and rivers of Uttaranchal region and supplements the nutrition and income of the hill people, is also declining and needs some measure to conserve its population Brown trout (*Salmo trutta fario*) and rainbow trout (*Oncorhynchus mykiss*) are present only in limited streams and their farming is yet to take off.

The fish yield from the lacustrine resources is very poor main due to eutrophication/pollution of the lakes. The unscientific introduction of fishes (including exotic species) has adversely affected the native fishery, resulting in the extinction of mahseer and snow trout in some lakes such as Nainital. The native fisheries of the

being only 20-40 kg/ha. Development of large scale populations of weed fishes and catfishes are the chief causes for low fish yield. Improper stocking policy is also one of the main factors for reduced fish yield . The native fishery of reservoirs represented by medium sized carps such as *Puntius sarana, Cirrhinus reba, Labeo calbasu, Labeo gonius* etc. has greatly declined.

The polyculture of Indian major carps and exotic carps is the chief fish farming system in the plains of Uttaranchal. However, fish farming at high altitude is a limited activity; only culture of Chinese carps *viz.* silver carp and grass carp is being practiced at some places.

For the development of fishery in the aquatic resources of Uttaranchal, integrated approach is urgently required including the action plan for both culture and capture fisheries. The rehabilitation of deplited fishery of mahseer is urgently needed. It calls for broodstock management of golden mahseer and snow trout, and intensive seed production of the same is required for stocking in the selected rivers and lakes. Similarly, broodstock development and seed production of brown and rainbow trouts is necessary to develop the fishery of this most priced fish species for table rearing and ranching for sport. The culture of trouts in private sector has to be encouraged.

Fish production in lentic systems can be enhanced after restoration of lake ecosystems, followed by stocking of ecologically compatible fish species. Cage and pen culture of suitable fish species can be adopted to further enhance the fish production without affecting the lake ecosystems. Development of sport fisheries, *in situ* conservation of native species and declaring of snactuaries and national parks will enhance the opportunities for eco-tourism. Intensive srvey of the fishery resources of Uttaranchal should be done so as to obtain baseline data for the development of policies for sustainable, environmental friendly fishery in the State . The paper gives a blue-print of development of fisheries and aquaculture in Uttaranchal .

A-21

INTEGRATED FISH FARMING - A SUCCESS STORY

C. S. Singh
Former Dean Fisheries (Pantnagar)

Singharia (Near Ashoka Gas Godown),
Kunraghat, Gorakhpur - 273 008 U.P.
Shekhar Farm, Krishak Shansadhan Vikas Sansthan
Phulwaria, Bhatpar Rani, Deoria (U.P.)

More than three fourth of the indian population live in the rural areas of the country. At present their tendency is to migrate from rural areas to the urban areas for their need based requirements. They need animal protein to their diet, gainful employment and sustained income. Their land holding are small and modern large scale production technology with high input requirements are no solution for their problems. A low cost integrated farming system will be suitable for our farmers based on the principles of productive utilization of farm wastes and fuller utilization of available resources and manpower.

The package of practices for fish-cum-dairy, fish-cum-pig, fish-cum-duck, fish-cum-poultry and fish-cum-agriculture farming systems have been developed and verified extensively for economic viability and feasibility at the farmer's level. The systems can be adopted by suitable modification in appropriate areas (agro - climatic zones) where water resources, healthy stock of animals and agricultural land are available . In the past, various models were proposed for commercialisation of agriculture on integrated farming system representing a successful technique for marginal farmers. The synergistic benefits of true integration, however will require recycling of nutrients and other resources from enterprise to enterprise . Author has successfully developed a model farm in 1.75 ha (around 4 acres) with fish ponds serving as effective bioreactors in the process substantialy improving whole farm productivity.

A-22

SNOW-TROUT FISHERY IN HIMALAYAN UPLANDS

Shyam Sunder

National Research Centre on Coldwater Fisheries,
Bhimtal - 263 136 Distt. Nainital (Uttaranchal)

Snow-trouts, generally the denizens of mountainous zones are important from evolutionary, taxonomic and zoogeographical view point. Based on the nature of streams, schizothoracids mostly occur from rapid coldwater zones to rapid turbid zones besides lacustrine systems in himalayan uplands . Of late, on account of their proximity to anthropogenic interventions, the group is facing multipronged dangers and threats primarily posed by upcoming of river valley projects, network of roads and other developmental schemes, unchecked fishing by spurious methods leading to intensive exploitation, changing land-use-pattern, over abstraction of water and building material, destruction of forest cover, denudation causing high siltation. All these factors in one way or the other, have adversely affected the feeding and breeding niches of the fish.

Such a sorry state of affairs warrants foremost attention for the revival and rehabilitation of the precious schizothoracid fishery which may not merely be restricted to passive conservation in open waters but the quantitative improvement of stocks through constant ranching programs of farm produced stockable size material.The write-up reflects in brief the status , constraints and the conservative approaches for rejuvenation of snow-trout fishery in himalayan biotopes.

B - FISHERY ENHANCEMENT

B-1

BIOTIC SPECTRUM OF A HILL STREAM (MANAS) OF ASSAM

*Bulbul Acharjee, A. Dutta and M. Choudhury**

Department of Zoology, Gauhati University, Gauwahati-781 014
***Northeastern Regional Centre (CIFRI)**
Housefed Complex, 4rth Floor, Central Building, Dispur Guwahati-781 006

With a catchment area of 41,350 sq. km, river Manas, a hill stream and tributary of the mighty Brahmaputra river originating from the Himalayan kingdom - Bhutan is bestowed with valuable and varied fish germplasm and pristine water resources. The river traverses a distance of 150 km in the plains of the Brahmaputra valley and passes through the famous Manas wildlife sanctuary to its confluence with the river Brahmaputra. An investigation was carried out during the period 1999-2000 with a view to explore the biotic spectrum and fishery potentials of the river.

Poor concentration of plankton biomass was observed ranging between 52 and 177 u l^{-1} and was mainly constituted by Bacillariophyceae (52%) followed by Chlorophyceae (41.8%). Phytoplankton (166.0 u l^{-1}) dominated over zooplankton (11.0 u l^{-1}). Zooplankton had a well balanced distribution- rotifers (13.6%), rhizopods (10.0%), cladocerans (10%).

The benthic fauna mainly comprised of aquatic insects. Nymphs and adults of may fly and stone fly contributed to the benthic life. Average number of benthic organisms encountered during the study period ranged from 4 to 85 nos. m^{-2}. Gastropods contributed 81.7% to the population. Behaviour of biotic communities seems to be greatly affected by steep gradient, high velocity of current and low

Manas wildlife sanctuary located around the river manas was Fish Anglers paradise till recently. The habitat and distribution of fish species encountered in the region vary widely. This area abounds in sport fishes like *Tor tor, T. putitora, Neolissocheilus hexagonolepis, Labeo dero, Schizothorax richardsonii, S. plagiostomus, Crossocheilus latius* besides major carps- *Labeo rohita, L. calbasu , Catla catla and Cirrhinus mrigala;* catfishes-*Wallago attu, aorichthys seenghala, A.aor, Mystus tengra;* featherbacks *Notopterus notopterus, N. chitala* besides *Barilius bendelensis, Garra gotyla, G. nasuta* and *G. lamta.* A few ornamental fish species have also been recorded from the river Manas *viz. Hara hara, Chaca chaca, Puntius gelius, Batio dario, Badis badis, Colisa fasciata, C. lalia, Bagarius yarrelli, Chanda nama, Chanda ranga* etc.

The physico- chemical factors recorded were as follows : Water temperature 19.0-21.0^{0}C, dissolved oxygen 7.0-8.3 ppm, pH 7.4-7.7, total alkalinity 75.0-80.0 ppm, silicate 0.4-0.59 ppm . Nitrate and phosphate were recorded in traces.

Indiscriminate killing of brood fishes, dynamiting, poaching have greatly affected the fishery structure. Soil erosion due to large-scale deforestation in the hilly region resulted in high rate of siltation and loss of breeding grounds for carps and sport fishes.

B-2

FISH AND FISHERIES POTENTIAL, ITS PROSPECTS AND PROBLEMS OF THE NORTH EASTERN HIMALAYAN RIVERS

Umesh C. Goswami, Dilip Borah and Sudip K. Basisth

Department of Zoology, Gauhati University, Guwahati 781014 (Assam)

The Himalayas with the great ranges extending from the north to the northeast in the Indian sub-continent furnish large sources of aquabodies. A large of number of rivers, streams and high altitude reservoirs with the Ganges and Brahmaputra river systems afford lucrative aspects of various kinds of ichthyo-species.

The fish fauna inhabiting the rheophilic or high altitude of the himalayan aquabodies have specialized and specific modes of adapting to their different habitats. The adaptation, food and feeding habits and reproductive strategies are unique and show marked differences in comparison with the fish of the plain water system. The occurrence of *Anguilla bengalensis, Bagarius bagarius, Chagunius chagunio, Crossocheilus latius latius, Garra gotyla, G. lissorhynchus, Neolissochelius hexagonolepis, Semiplotus semiplotus* besides few species of *Schizothorax, Barilius* and *Labeo* etc. are commercially important species and provide lucrative prospects for their future culture and propagation in high altitudes.

Highly saturated with oxygen along with blooms of algal species affording food for the above mentioned fishes depict good potentialities for rheophilic pisiculture in various stream sites of the northeastern himalayas.

At present, high altitude fishes are facing serious threats from human interference and the use of illegal materials, electrocution, intensive fishing, use of small mesh size nets etc. These problems have posed serious threats to the endangered species of fish dwelling in those habitats. In the present communication , the details of the fish and fishery potentials in the northeastern himalayas and some of problems would be presented.

B-3

ECOLOGICAL DIVERSITY AND BEHAVIOUR OF SCHIZOTHORACIDS : QUANTITATIVE ASSESSMENT AT COMMUNITY LEVEL

N. Singh and K.C. Bhatt

Department of Zoology, P.O. Box 83, H.N.B. Garhwal University, Srinagar Garhwal -246 174 (Uttaranchal)

The ecological diversity and behaviour of three closely related species - *Schizothorax richardsonii* Gray, *Schizothorax plagiostomus* Heckel and *Schizothoraichthys progastus* McClelland (Family, Cyprinidae; Subfamily Schizothoracinae)-comprising the Schizothoracid community have been analysed quantitatively. It reveals how these species are interrelated and respond to changing surroundings in a fast flowing fluvial system of unidirectional flow and gradient where both the subject and environment are mobile. The observations were made at four sampling sites on the upland river Mandakini that covers over 30 km of lower stretch from January 1991 to December 1992. The monthly data were analyzed for- 1.Diversity indices : Shannon's species diversity index (h) Evenness index (e) and Margalef's community diversity index (d), 2. Similarity indices: *Coefficient of similarity* (CS) and *Index of dissimilarity* (ID). The results of these indices on the Schizothoracid community express distinct pattern of quantitative assay during March, April, May (first breeding season), June, July (non- breeding season) August, September, October (second breeding season) and December, January, February (non- breeding season). The Schizothoracid community appears to be stressful during June, July (peak monsoon), December, and January, February (extreme winters) and also in the upper stretches. Two sampling spots- Chandrapuri and Tilwara where smaller rivulets debauch in the mainstream- offer better, more varied and livable surroundings thus, attracting a large number of individuals, population and species for feeding, breeding etc.

B-4

STATUS AND PROSPECTS OF CULTURE -BASED - CAPTURE FISHERIES DEVELOPMENT IN UTTARKASHI DISTRICT OF UTTARANCHAL

R.S. Chauhan, U.P. Singh and K.S. Mehta

Department of Aquaculture,
College of Fishery Sciences,
G.B. Pant University of Agriculture and Technology,
Pantnagar-263 145 (Uttaranchal)

About 14 km up Uttarkashi on the bank of Asiganga stream is located a very old trout hatchery named Kaldyani Trout Hatchery. Britishers established the hatchery about a hundred years back. The hatchery is in dilapidated condition. Some renovation work is in progress. Two new tanks of 200 m^2 area each have been constructed. The old ova-house has been demolished. The make shift hatching facility includes two hatching troughs of the size of 1.80 x 0.43 x 0.25 m each with total capacity of incubation of 4000 trout eggs at a time. The water source- Asiganga, has crystal clear, highly oxygenated water with the temperature of about 5 to 15°C. The local people apprised about the availability of brown trout upto 7.5-kg in Asiganga. Unbelievable but true, the brown trout of 2.5 kg was caught during last part of 2001, verifying the recruitment and establishment of brown trout in Asiganga, the second largest river in the district after Bhagirathi. Ample amount of water of suitable quality and infrastructural facilities is available at Kaldyani.

A large and beautiful lake, Dodital, is located at an altitude of 3050 m asl. It is 24 km trekking from Sangamchatti to Dodital. A big spring feeds the lake. The area of lake is about 12 ha. The water temperature ranges from freezing point to about 12°C. The brown trout, introduced by Britishers about 100 years ago are still existing in the lake. The fish upto 1.5 kg has been seen by the authors. Dodital is a remote place visited only by trekkers, anglers, some adventurists and personnel's from forest department. The fishery development is discussed in the paper.

B-5

FISH AND FISHERIES OF RIVER WESTERN RAMGANGA IN KUMAON HIMALAYA

P. Sanga, A.U.Khan, C.B.Joshi and Shyam Sunder

National Resarch Centre on Coldwater Fisheries, Bhimtal -263 136, Distt. Nainital (Uttaranchal)

Kumaon Himalaya is one of the two divisions of Uttaranchal state situated at 28°43'55" - 30°33'12" N Lat. and 78°44'30" - 80°5' E Long. With a total area of 21,035 km² having great lotic water potentials in the form of various rivers *viz*; the Kali, the East Ramganga, the Pinder, the Saryu, the Gomti, the Kosi ,the Gaula and the Western Ramganga. Among these, the Western Ramganga system has a special significance because of it's rich fishery potentials.

During the study period (2000-2001), extensive survey of the river system as well as it's important tributaries was conducted to enumerate the fishery potentials. The fish fauna mainly comprised *Tor putitora, Garra gotyla, Labeo dero, Labeo dyocheilus, Schizothorax richardsonii, Barilius bendelisis, Barilius vagra, Nemacheilus montanus, Mastacembelus armatus, Glyptothorax pectinopterus.* The CPUE values on the basis of the experimental fishing ranged from 156 - 3450 g / man/ hr. The significant fish groups encountered were Cyprinidae (85.19 - 98.99%), Belonidae (0.0 - 3.23%), Balitoridae (0.0 - 12.35%), Mastacembelidae (0.0 - 3.70 %), Cobitidae (0.0 - 4.05 %) and Sisoridae (0.0 - 2.16%).

The overall fish catches in Western Ramganga and it's tributaries have shown significant seasonal variations depending on the certain bio- ecological characteristics. The present write - up describes in detail the fisheries of the system in relation to certain hydrobiological parameters.

B-6

OCCURRENCE AND ABUNDANCE OF PHYTOPLANKTON IN SARYU RIVER SYSTEM OF KUMAON HIMALAYA

P. Sanga, A.U.Khan, C.B.Joshi and Shyam Sunder

National Resarch Centre on Coldwater Fisheries
Bhimtal -263 136, Distt. Nainital (Uttaranchal)

The diversity and abundance of phytoplankton in Saryu river system of Kumaon Himalaya has a special significance as it support the fishery of the variety of hill stream fishes including the snow-trout and mahseer. The studies conducted during 2000-2001 revealed that in R. Saryu the phytoplankton constituted the bulk contributing 97.74% of the total planktonic assemblages. It has been observed that the Saryu river system including its important tributaries- the Gomti and the Ramganga (E) is rich and diversified with the occurrence of 59 genera of phytoplankton, of which 32 recorded from the river belong to Bacillariophyceae (diatoms) , 17 to Chlorophyceae (green algae) and 9 belong to Cyanophyceae (blue- green algae). Only one genera (*Ceratium* spp.) belonging to Dinophyceae has also been recorded. The average density of these groups in the total phytoplankton community has been observed as 85.26%, 11.67%, 2.90% and 0.17% respectively. The total standing crop of phytoplankton in this river system ranged between 371-694 u /l in the upper stretch and 340-605 u/l in downstream. The important genera encountered were *Bacillaria. Cymbella, Navicula* and *Synedra* among Bacillariophyceae; *Schizogonium* and *Spirogyra* among Chlorophyceae and *Amphithrix*, and *Anabaena* among Cyanophyceae.

B-7

MACROBENTHIC INVERTEBRATE FAUNA OF RIVER SARYU IN KUMAON HIMALAYA

A.U. Khan, P. Sanga, Shyam Sunder and C. B. Joshi

National Research Centre on Coldwater Fisheries, Bhimtal- 263 136 Distt. Nainital (Uttaranchal))

Studies on macrobenthic invertebrate fauna of River Saryu were undertaken for two years during 2000-2001. The major population of macrobenthic invertebrates in the Saryu comprised mainly the larval, nymphal and pupal stages of aquatic insects (>97%). Rarely small fishes, molluscs nematodes, leeches etc. were noticed in the samples. Total benthic population ranged from 12 ind/m^2 to 183 ind/m^2 (71 ind/m^2) whereas their wet biomass fluctuated between 1.194 -7.150 g/m^2 (2.615 g/m^2).

A total of 43 macrobenthic invertebrates have been recorded from River Saryu during study period, of which 8 belonged to Ephemeroptera, 9 to Trichoptera, 9 to Diptera, 4 to Plecoptera, 3 to Hemiptera, 5 to Coleoptera, 2 to Odonata and 3 to miscellaneous groups.

It has been observed that the composition, distribution and seasonal fluctuations of macrozoobenthos varied during both the years at the same site and within the same year at various sampling sites in River Saryu which might be attributed mainly to the disturbance of the habitat. The other major causes responsible for the uneven distribution of benthic fauna in the river were mostly the floods, removal of sediments (sand, stones etc.) , turbidity, erratic water flow etc.

B-8

FISH ABUNDANCE AND ITS RELATIONSHIP WITH ENVIRONMENTAL VARIABLES IN A FRESHWATER HIMALAYAN LAKE - BHIMTAL

Y. Basade

National Research Centre on Coldwater Fisheries, Bhimtal- 263 136 Distt. Nainital (Uttaranchal)

Bhimtal is situated at an elevation of 1332 m above msl between the latitude 29°30' N and longitude 79°36' E and has total water surface area of 84.2ha. It is one of the largest lake among the eleven lakes located in Kumaon Himalaya. The study was conducted from 1991 to 1995 to examine the fish abundance in lake Bhimtal and the relationship of fish production to the environmental variables namely, rainfall in the region and mean water depth of the lake. Fish species richness decreased from seven in 1991 to four in 1995. The indigenous *Tor putitora* dominated the catches accounting to 42.24% followed by *Cyprinus carpio* 41.94%. While the Indian major carps- *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*; Chinese carps- *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella* and snow-trout *Schizothorax richardsonii* formed only a minor proportion of the catches. The production of *Tor putitora*, *Schizothorax richardsonii* and *Cyprinus carpio* increased from 1991 to 1995 but the maximum size of fish caught decreased from 7.3kg to 2.2 kg in case of *Tor putitora*, from 5.5kg to 3.7kg for *Cyprinus carpio* and from 0.450kg to 0.400kg for *Schizothorax richardsonii*. Whereas, the production of *Catla catla*, *Labeo rohita*, *Cirrihinus mrigala*, *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella* decreased from 1991 to 1995 but the maximum size of fish caught showed an increasing trend with passing of years. The total fish yield from the lake exhibited positive correlation with the two independent environmental variables *viz*., rainfall ($r = 0.61$, $p < 0.40$) and mean water depth ($r = 0.87$, $p < 0.01$). The influence of rainfall and mean water depth was statistically significant in determining fish yield. The multiple regression model also showed positive correlation ($R2 = 0.98$, $p > 0.05$) and was found to be a better predictor of fish yield and can serve as a working model for the management of aquatic system.

B-9

ICHTHYO-BENTHIC FAUNAL DIVERSITY AND ECOLOGICAL DATA PATTERNS OF AQUATIC RESOURCES IN UTTARANCHAL HILLS FOR IDENTIFYING PRIORITY AREAS FOR CONSERVATION

A.K. Singh, Shyam Sunder and H.S. Raina

National Research Centre on Coldwater Fisheries
Bhimtal-263136, Distt. Nainital (Uttaranchal)

The major rivers of Uttaranchal are 312 km long Ganga (major tributaries are Bhagirathi, Bhilangana, Alaknanda, Nandakini, Pinder, Nayar) covering 95,5000 sq.km water area, 220 km long river Kali (major tributaries are Dhaul, Kali, Gori, Saryu, Gomti and Eastern Ramganga) covering, 10870 sq. km water area and river Yamuna with its tributaries Tons and Algar. Survey studies were conducted for resource assessment and aquatic biodiversity evaluation of various river systems and their tributaries at altitudes of 500-2000 m asl. The water flow of these rivers ranged from 0.9 to 5.6 m/sec, the thermal regime remained between 6.0 to 21.5°C, water quality of these systems remained alkaline (pH above 7.4) and highly oxygenated (dissolved oxygen above 8.5 mg/l) with total alkalinity ranging between 42 to 112 mg/l.

In these streams, epiphytes and phytoplankton represented a large population of primary producers, which serve as food for zoobenthos and herbivore fishes. The phytoplankton population was mainly dominated by Bacillariophyceae (above 80%) followed by Chlorophyceae and Desmidiaceae with their density ranging between 150-550 units/l. The zooplankton population was fairly low in these systems ranging between 15-35 units/l. The density and diversity of benthic population reflects high productive potential both quantitatively and qualitatively. The benthic population was dominated by Ephemeroptera (2.8-65.5%) followed by Trichoptera (4.3-45.0 %), Coleoptera (1.5-17.5%) and Odonata (upto 5.0%).

(2.0-10.0%). Apart from these, other ichthyodiversity elements were *Labeo dero, Garra gotyla, Barilius bola, B. bendelisis, Glyptothorax* sp. *Noemacheilus* spp. etc. Brown trout (*Salmo trutta fario*) was also recorded in lesser magnitude in the river Birehi, Bhagirathi and Pinder. A total of 38 fish species have been recorded from the Garhwal region. Majority of fishes are caught individually by local fishermen in the rivers and streams and do not form the fisheries of commercial catch. The average catch per person with their conventional gears ranges 155-1500 g per day.

From correlation of various data on ecological parameters, benthos, fishery spectrum and social conditions, it is concluded that species communities and habitats have poor preservation status and these are in the first priority reserves. Conservation status of different species from various river stretches and streams have been assessed from the data matrix. The problems emanating from the trade-off those are concerned with the biodiveristy of different areas has been assessed. It is imperative that the biodiversity conservation requires planning keeping in view the realities of limited resources and the competing demands of the society. In this paper, the existing data has been evaluated and analyzed in the light of precisely defined goal for identifying biodiversity conservation priority area.

B-10

HABITAT UTILIZATION AND DEPTH DISTRIBUTION OF SOME HILL STREAM FISHES IN KUMAON HIMALAYA

U.K. Sarkar, P.C.Mahanta, S.M. Srivastava, R.S.Patiyal , S.K.Paul and Madan Lal

National Bureau of Fish Genetic Resources, Canal Ring Road, Dilkusha, Lucknow- 226 002 (U.P)

The Kumaon Himalayan Region is endowed with rich diversity of water resources both lentic and lotic and harbours several endemic fish species . Until now , there has been little documentation of habitat utilization patterns by the early life stages of hill stream fishes. The present paper describes the habitat utilization of early life stages of endangered mahseer *Tor putitora*, snow trout *Schizothorax richardsonii* and *Barilius bendelisis*. During 1998 to 2000 , sampling was carried out in the streams of Kumaon Himalaya and data was collected on the occurrence and assemblage of early life stages of above fish species in the different micro-habitats. Different types of micro-habitat utilization was observed. It was revealed that the early life stage of mahseer (*T. putitora*) preferred riffles with very low water depth and zero velocity area in maximum cases. The preferred substrate type was those where pebbles and gravels are dominant. The density of *Schizothorax* sp. was high where epilethic algae and detritus was available. *Barilius bendelisis* was found to assemble in the shallow pools and riffles. Two way analysis of variance (ANOVA) between distribution of early life stage of *Schizothorax* sp. and *Barilius bendelisis* against altitude was significant (P = 0.0004) while in *Tor putitora* it was non-significant (P=1.56). Present observations emphasize the necessity of undertaking spatio- temporal analysis of fish habitat utilization so that measures can be taken up for stream habitat management.

B-11

PRESENT STATUS, FUTURE PERSPECTIVES AND CHALLENGES FOR DEVELOPMENT OF MAHSEER FOR SPORT FISHERY IN RESERVOIRS OF MADHYA PRADESH

Ankush Saxena and Praveen Tamot

M.P. Council of Science and Technology,
Vigyan Bhawan, MACT Campus, Nehru Nagar, Bhopal. 462 003.

Madhya Pradesh, the centrally located State of India, is bestowed with a rich faunal biodiversity. Seven river basins provide vide variety of geographical conditions in the State to harbour more than 170 fish species of different habits and habitats. Among them, mahseer (*Tor tor*) is considered good for food value. But this fish is far better known for its sport value. Mahseer is spread over in Narmada river basin and its tributaries. As a migratory fish, it has been reported in most parts of Narmada river. But during last three decades construction of reservoirs has hampered its migration. This has adversely affected its reproduction in the river in natural conditions. A number of reservoirs have suitable geographical conditions for growth of mahseer. But continuous fishing and no stocking have depleted mahseer stocks in these reservoirs. It is required to stock these reservoirs with mahseer fingerlings.

The paper describes activities initiated for conservation and development of mahseer in Madhya Pradesh. A flow-through hatchery has been developed by MAPCOST at Powarkheda centre of CIFE with financial assistance of ICAR. The seed is produced at this centre and released in few selected reservoirs of the region. A survey has also been conducted in various reservoirs for their limnological conditions and suitability for development of mahseer.

A number of reservoirs are existing which can be developed for mahseer. Chandpatha, Tawa, Kerwa, Kolar, Ratapani, etc. have geographical and ecological conditions, which are ideal for development of mahseer. It is required to take proper initiatives to restore mahseer population in these reservoirs for sport fishery. This will generate revenue, which may be used for their development. These places may be

B-12

TOWARDS CONSERVATION, MANAGEMENT AND UTILIZATION OF FISH BIODIVERSITY IN UPLAND HIMALAYAS

P.C. Mahanta

National Bureau of Fish Genetic Resources,
Canal Ring Road, P.O. Dilkusha, Lucknow (U.P)

The vast himalayan upland belt in the Indian sub-continent covers major parts of the hill and mountain in India. Two important distinct geographical parts of this vast range are north-eastern covering Assam, Meghalaya, Manipur, Mizoram, Arunachal Pradesh, Nagaland, Tripura, Sikkim and parts of Darjeeling, whereas north-western spreading a geographical area of 53.8 million ha is inhabited by 64 million people. The altitudinal variation is about 50 to 7000 m above msl and the temperature zone varies from sub-zero to 38-40°C in plains. Regional differences in rainfall are 800 to 4000 mm in NE whereas 1600-2600 mm in NW. Both the regions have three important drainage systems namely, Indus, Ganges and Brahmaputra with numerous important tributaries and wetlands. As a whole, these mighty drainages harbour India's most prized fish genetic materials. Two primary aquatic zones prevail in these regions - one is coldwater and the other is warmwater. Some of the important high cold region species are snow-trout, *Schizothorax* spp. and *Schizothoraichthys* spp.and the low cold region species are world famous legendary mahseers, *Tor* spp. besides *Bagarius* spp. and innumerable ornamental fishes. On the other hand, the warmer region harbours commercially important carps, *Labeo* spp., *Catla catla*, *Cirrhinus mrigala* and non target commercially important species like *Notopterus, Ompok, Silonia, Semiplotus* and some catfishes etc. Out of about 600 fresh water species recorded so far in Indian sub-continent, 79 have been identified as threatened. Due to wanton destruction of habitat, fish germplasm has depleted at an alarming rate which is a known fact. Population pressure has led to such a stage that unless programmes are not taken to protect the environment, the precious wealth of fish germplasm will be lost in no time. The forest cover has gone down below 50% in most of the areas. Soil runoff is very high causing heavy uncontrolled siltation destroying the natural habitats and the breeding grounds. Although the region experiences

of the resources. Unscientific and uncontrolled damage of the natural aquatic resources created havoc which in turn have tremendous effect on the socio-economic bond of the society. Strategic plans for conservation and managing natural resources, sustainable genetic resource conservation and utilization, soil conservation, water management are some of the important steps which are needed. The terrain is rough, weather is uncertain, so to harness the fish biodiversity, special attention is required to develop suitable package of practice, tools and above all, human resource development and management. Some of the prioritized action points are food security, sustainability, diversification of high value research with export potential, seed production etc. Although it is clear that the hills and mountains referred in the paper are endowed with rich genetic diversity in terms fish, both the zones are the primary or secondary source of many species. If judicious use of genetics and biotechnological approaches are taken to protect and flourish the germplasm, there is a tremendous scope to develop an export-oriented industry by harnessing the ornamental fish resources. The entire region especially the NEH region is prone to a number of biophysical, institutional and socio-economic problems resulting into low productive technology. One of the important factors is the land tenure system, which is an essential condition needed to fasten investment in productivity-enhancing, resource-conserving technologies. It is also one of the important constraints for not taking up hill aquaculture in an extensive way. The major challenges would be to develop suitable / feasible aquacultural practices like running water culture, use of paddy fields (terraces), game and sport fishing linked to tourism etc. for optimizing productivity without resource degradation taking into account the economic and cultural conditions of the ethnic population. However, when we talk about hill and mountain aquatic resources, it must be integrated with other biotic resources for their sustainable management and utilization.

B-13

CONSERVATION OF FRESHWATER FISH BIODIVERSITY OF INDIA: A POLICY AND PLANNING PERSPECTIVE

S.P. Singh, L.K. Tyagi, U.K. Sarkar and Karan Veer Singh

National Bureau of Fish Genetic Resources,
Canal Ring Road, P.O. Dilkusha, Lucknow (U.P)

Legislation related to agriculture and allied activities including fisheries are jurisdiction of State Governments. If we look critically towards past efforts in legislation development in agriculture and allied sectors, it is clearly visible that in constitution of such legislation, there have been mostly duplications among different states. With a few exceptions, people are not aware of these legislation. Even some implementing agencies are also not adequately aware of these laws. Review, incorporation of feedback and updation of these laws has also not been adequate. These issues about legislation and policy related to fisheries and fish genetic resources will have long term impact on economy, employment, ecology, environment and natural resources of the nation.

To provide consistent support for constitution of suitable dynamic legislation and policy alongwith its evaluation, updation and viability, it is essential to develop techniques to (i) quantify evaluation of aquatic system (ii) assess genetic wealth therein (iii) prioritize commercially important species/strains for different purposes (iv) integrated aquatic resources with land resources associated animals and culture system (v) integrate indigenous, modern and frontier knowledge to associate with developing farm practices (vi) evolve socio-economically viable farming system with aquaculture (vii) include more species in aquaculture for diversifying (viii) identify suitable species with package culture for newly developed watersheds (ix) develop cottage industries and trade promotion to add more value for production and product (x) plan long term integrated system of generating primary statistics needed at national and global levels (xi) develop robust analytical tools for time series and multivariate data using computer for optimum planning and interference (xii) dynamic policy system to monitor and modify policies and programme implementation and (xiii) network NGOs and frontline progressive farmers

B-14

ECOLOGY AND FISHERIES OF HILL STREAMS OF NORTH EAST INDIA - A REVIEW

M. Choudhury and B. K. Bhattacharjya

Northeastern Regional Centre,
Central Inland Capture Fisheries Research Institute,
Housefed Complex, Dispur, Guwahati

The northeastern region of India comprising seven states *viz.* Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura covers a geographical area of 2,55,083 sq. km supporting 39 million people affiliated to more than 100 different tribes and ethnic groups. The rich ichthyofauna resources of the region comprise 297 fish species belonging to 114 genera under 38 families and 10 orders and include as many as 31 endemic fishes. The ichthyofauna of the region forms about 33 % of the total Indian freshwater fishes. Assam has the highest number of ichthyospecies (218) followed by Arunachal Pradesh (167), Meghalaya (165), Tripura (134), Manipur (121), Nagaland (68) and Mizoram (48).

The important hill stream fishes of the region which doubles both as food and sport fisheses are *Tor tor, T. putitora, T. progenius, Neolissocheilus hexagonolepis, N. hexastichus, Schizothorax richardsonii, Schizothoraichthys progastus, Labeo dyocheilus, Raimas bola, Garra* spp. In addition, exotic rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) have established in hill streams of Arunachal Pradesh (both species), Meghalaya and Nagaland (brown trout). Sport fisheries offer tremendous scope for developing eco-tourism in the region. A good number of fishes like *Cyprinion semiplotus, Anguilla bengalensis bengalensis, Chitala chitala, Barilius bendelisis, Labeo dero, L. gonius, Puntius sarana sarana, Aorichthys seenghala, Rita rita, Ompak bimaculatus, Wallago attu, Eutopichthys vacha, Bagarius bagarius, Channa marulius, C. striatus, Mastacembelus armatus* support commercial fishery of the region.

Important ornamental fishes of the region are *Botia dario, Acanthocobitis botia, Balitoria herdmari, Brachydanio rerio, Barilius barna, Danio devario, D.*

chopri and *M. malcolmsonii*) and molluscs (*Pila giba, Lammnidens* spp.) were recorded in rivers of the region.

A large variety of crafts and gears are operated in the rivers for exploiting their muiltispecies fishery. The entire fleet of crafts is non-mechanised and ranges from large plank-built boats to indigenous dug out canoes and rafts. A wide range of gill nets, shore seines, Chinese dip nets, cast nets, line fishing and traps are employed to catch fishes in the rivers. In the fast flowing small hill streams, fishes are caught by indigenous methods like flow diversions and application of plant piscicides. Destructive fishing practices like using explosives were also observed. Community fishing in hill streams using plant piscicides was found to be customary in most tribal societies.

Studies on physico-chemical quality of water of selected hill streams indicated cool temperature (10-30^0 C), high dissolved oxygen (6.6-9.3 mg / l), alkaline pH (7.0-7.6), medium alkalinity (37.6-82.6 mg / l), fluctuating total hardness (14-190 mg /l), low levels of nitrate (0.02-0.1 mg / l) and phosphate (0.002-0.032 mg / l).The gross primary productivity of the selected rivers ranged between 249.6-1500 mg C /m^3 /d^1

Studies on the biotic communities in rivers revealed poor plankton populatios. The average abundance of plankton was as follows: Arunachal Pradesh (18-258 u /l), Mizoram (14-137 u/l), Manipur (13-30 u/l), Meghalaya (11-34 u/l), Nagaland (18-122 u/l) and Tripura (20-27 u/l). Plankton community was overwhelmingly dominated by phytoplankton. The abundance of periphyton was considerable as compared to that of plankton and ranged from 2880-8654 u /cm^2 (Arunachal Pradesh), 60000-97200 u /cm^2 (Mizoram), 2350-45300 u /cm^2 (Manipur), 1350-6000u/ cm^2 (Meghalaya), 13100-97500 u / cm^2 (Nagaland) and 480-1200 u / cm^2 (Tripura).Benthos population was found to be low (64-350 no./ m^2 in Arunachal Pradesh, 27-509 no./ m^2 in Mizoram, 7-255 no./ m^2 in Manipur, 8-223 no./ m^2 in Meghalaya, 159-508 no. / m^2 in Nagaland and 64-254 no./m^2 in Tripura.

Despite having vast potentials, fish production from the selected hill streams of northwest was found to be very low. The reasons for such situation are discussed in the paper.

B-15

COLLECTIVE GRASSROOT INITIATIVES FOR CONSERVATION AND MANAGEMENT OF FISHERY RESOURCES IN THE HILLS

L.K. Tyagi, P.C. Mahanta and S.P. Singh

National Bureau of Fish Genetic Resources
Canal Ring Road, P.O. Dilkusha, Lucknow - 226 002

India has significant aquatic resources in terms of upland rivers/ streams, high and low altitude natural lakes and man-made reservoirs in its hilly areas. These water bodies harbour large population of both indigenous and exotic cultivable and non-cultivable fish species. This fish fauna is an important component of the freshwater fishes of India. The region is also known for valuable sports fishes like golden mahseer. Over the years, however, due to cumulative effect of different anthropogenic factor like over exploitation, use of nets of small mesh size, unscientific and spurious fishing methods (*e.g.* explosives, poisoning) prevailing in the region, the valuable fish fauna is depleting. The need to undertake measures for conservation of these valuable resources has, of late, been recognized. However, what needs to be given the top priority in the conservation measures is the mobilization of people's collective will and energy at the grassroot level for becoming active partner in the conservation. Natural resources, which belong to the common property regime, require community and co-operative efforts for their protection and development. Though outside technical guidance is also required for conservation of natural resources, conservation initiatives succeed in achieving their objectives only when people at the grassroot level understand the conservation priorities and actively contribute in the making of these initiatives.

Several examples of successful conservation initiatives are available in different sectors like forest conservation water conservation etc. in different developing countries as well as in our own country. There are cases where local communities have not only conserved but even revived the 'dead' rivers, ponds and lakes in different parts of the country by grassroot community efforts. This strategy of mobilizing community initiatives of directly concerned people at the grassroots level can as well be applied for conservation and sustainable management of fishery resources in the hilly areas. Government agencies need to join hands with the NGO's to create a collective

B-16

BIOMASS AND SECONDARY PRODUCTION OF MACROINVERTEBRATE BENTHOS IN A SMALL SPRINGFED STREAM, GARHWAL HIMALAYA

Manju Prakash Gusain, O.P. Gusain and Raghav Datt

Freshwater Biology Labrotary, Department of Zoology,
HNB Garhwal University, Srinagar-Garhwal, Uttaranchal 246 174

Considering the importance of the macroinvertebrate benthos as a major food source of the indigenous fishes in small spring-fed streams in the Garhwal region, atttempt has been made in the present investigation to measure the secondary productivity of one such fluvial system namely, Bachchan Gad . It is approximately 12 km long left side tributary of river Alaknanda, which meets the later about 20 km ahead of Srinagar township enroute to the super shrine Badrinath. In Bachchan Gad, the important fish included barils and trouts, which have a strong preference for macroinvertebrate benthos as food.

Samples of macroinvertebrate benthos collected from the four selected sampling sites (representing the upper, middle and lower sections of the stream) were identified, enumerated and weighed. The standing stock biomass was determined and expressed as dry weight per unit area per unit time. Ash free dry weight (AFDW) was obtained by ashing the samples at 500-550^{0}C. The secondary productivity was estimated by size frequency method.

The bulk of main constituent, which accounted for the benthic fauna in the stream were larvae, nymphs and micro-adults of 29 genera belonging to 08 orders of class insecta. The mean annual benthic biomass in Bachchan Gad varied between 0.114 ± 0.074 and 0.431 ± 0.412 g dry wt m^{-2} whereas, the total annual biomass recorded was between 1.371 and 5.162 g dry wt m^{-2} y^{-1}. The mean AFDW varied between 0.048 ± 0.036 and 0.264 ± 0.232 g AFDW m^{-2}. The total annual AFDW ranged between 0.579 and 3.045 g AFDW $m^{-2}y^{-1}$.

The secondary productivity was calculated between 1.407 and 2.48 g dry wt

with low biomass

Seasonally, the biomass of macroinvertebrate benthos in the stream was maxima during spring in first year (0.469±0.091-1.197±0.077 g dry wt m^{-2}). However, in the second year, it was maxima during spring at S1 only, whereas at S2, S3 and S4 maxima was during summer being 0.307±0.02, 0.807±0.511 and 0.119±0.013 g dry wt m^{-2}, respectively. Minima were recorded during monsoon and autumn during the study period

The macroinvertebrate benthos was significantly positively correlated with the density in first year ($r = 0.487$, $P > 0.05$ at S1; $r = 0.739$, $P > 0.01$ at S2; $r = 0.677$, $P > 0.01$ and $r = 5.25$, $P > 0.01$ at S4). However, no such relationship was observed during the second year, which besides other factors, can be attributed to the high percentage of diptera in all the samples at all the sites (as high as 43.48%).

B-17

FISHERY POTENTIAL AND ITS ENHANCEMENT IN NAINITAL LAKE

K. K. Vass , H. S. Raina, C. B. Joshi and R. S. Haldar

National Research Centre on Coldwater Fisheries
Bhimtal - 263136, Distt. Nainital (Uttaranchal)

Recently investigation has been undertaken to work out fishery potential and suggest an action plan for fishery restoration in Nainital Lake. An attempt has been made to indirectly estimate the potential on the basis of food - chain energy available in the system. Based on the energy conversions of the total primary net productivity, it is estimated that contribution of phytoplankton productivity is 2.9 x 10 g cal $m^{-2}yr^{-1}$ while macrophytes contribution additional 1.1x10 g cal $m^{-2}yr^{-1}$ totaling to 4.0 x10 g cal $m^{-2}yr^{-1}$ as energy source for secondary and tertiary food chain. Since the fish species in the systam mainly feed on primary and detritus chain, this cumulative energy is available to them for sustenance and growth. If we assume all the energy losses through different pathways operating in the lake and with known conversions from the published records (Vass and Zutshi, 1983), it is estimated that at a conversion efficiency of 0.5% between total primary productivity and fish, the Nainital lake has a potential to a fish yield of 167.5 kg $ha^{-1}yr^{-1}$ but on a conservative conversion of only 0.1% the potential will drop to 34 kg $ha^{-1}yr^{-1}$. On the other hand, when we apply the morpho - edaphic- index (MEI) model for potential estimation, the production falls in between 0.5 to 0.1% conversion efficiency. Based on these estimation a production enhancement is quite possible to the tune of 35- 70 kg ha^{-1} . Assuming a fish yield enhancement to 70 kg $h^{-1}yr^{-1}$ within an expected growth rate of 250 g per fish, on average per year, due to climatic constraints and allowing 20% additional stock for losses, the fingerling stocking should be 340 per hectare. This can be executed in two phases. In phase- I, it should have ratio of 40:60 common carp and silver carp and after the water quality improves during phase- II, the stocking ratio should be 30:50:10:10 comman carp, silver-carp snow-trout and mahseer. But the existing bilological productivity cannot be effectively transformed into fish biomass unless the water quality and nutrient load is reduced to the desirable levels. It is clearly observed that any fish rehabilitation programme will not prove a success unless the acceptable standards are met with. The fishery

B-18

DIURNAL RHYTHM OF SOME ABIOTIC AND BIOTIC PARAMETERS OF A HILL STREAM RAI OF DISTT. PITHORAGARH -- UTTARANCHAL

Kumkum Shah and B. P. Oli

Department of Zoology,
Govt. P. G. College, Pithoragarh,
Uttaranchal

The diurnal rhythm of some abiotic and biotic parameter of hill stream Rai at two sites were studied during rainy season on 4 th & 5th August 2000. This rivulet is used for domestic purposes in VIP areas of Pithoragarh as well as drinking and irrigation purposes by the near by villagers. The ichthyofauna consist of *Schizothorax richardsonii, Barilius bendelisis, Puntius ticto, Nemacheilus rupicola* etc.

Air temperature fluctuation was greater than that of water temperature. Dissolved oxygen and oxygen saturation percentage has the positive relationship with the water temperature. The pH and DO increased during the daytime and decreased during night, showing a negative relationship with free CO_2. The chloride contents wered lesser at daytime and higher at night. Free CO_2 and alkalinty exhibited a negative relationship with the temperature. Abundance of planktom (phytoplankton and zooplankton) showed a distinct diurnal variation.

B-19

RECENT DEVELOPMENTS IN COLDWATER FISHERIES AND ITS ROLE IN PROVIDING FOOD SECURITY TO HILL PEOPLE IN INDIA

B. N. Singh
Ex - Dy. Director General (Fisheries)

Indian Council of Agriculture Research
Krishi Anusandhan Bhavan - II
New Delhi - 110 012

An account of the water and fish resources of coldwater regions of India and early researches in biology, breeding and larval rearing of Indian coldwater fishes and exotic trouts show their great potential for sport and food fisheries. Recent researches have been concentrated on artificial breeding, larval rearing, seed production for enrichment of mahseer, trouts and other coldwater fishes in natural water resources. Establishment of hatcheries for seed production and farm facilities for culture of mahseer and trouts are essential for their profitable fisheries. The commercial scale hatchery production of the seed of khudree mahseer *Tor khudree* in Lonavla has created seed market for this fish in foreign countries. It was possible to export khudree mahseer seed by Tata Group from Lonavla. The culture of exotic carps in foot hills of Himalaya has yielded production @ 1157-2525 kg/ha/yr. Better fishery management practices evolved for reservoirs in Himachal Pradesh has increased production to about 100 kg/ha/y in Gobindnagar reservoir.

The exotic carps (silver carp) contribute significantly towards increasing production from Gobindsagar reservoir. The Pong reservoir's production in Himachal Pradesh has been increased to over 70kg/ha/yr. due to increased production of catfishes through scientific management. These reservoirs contribute significantly in providing nutritionally balanced feed *i.e.* "*Poor Person Cheapest Protein*" to local fishermen . The management of these reservoirs through fishermen cooperatives has resulted in increasing fish production through their participation and controlled stocking and harvesting. These practices need to be followed in the other hill states of the country for increasing fish production in Himalayan region and also in coldwater regions in other parts of the

and brood fishes of golden mahseer by legislation . The coldwater sport fisheries can flourish well as sport - trade in collaboration with department of tourism of India

Thus recent developments in coldwater fisheries offer great promise in contributing significantly to meet food and nutritional security of the people of hill region. Moreover, it can also contribute towards providing employment to rural fishermen / fisherwomen through sustainable fishery and management of natural waters through fishery cooperatives . Further, it may play a major role in promoting tourism in the hill regions through "*Sport Fishery Activity as well as conservation & biodiversity*" in collaboration with Ministry of Tourism and Ministry of Forest & Environment . Thus, coldwater fishery management and aquaculture development in the hills could be made as a policy for the integrated development by the state governments of the hill region for sustainable developments. This will improve the socio-economic conditions of the poor sections of the society in coldwater regions by providing livelihood activity to the people in Himalayas.

B-20

FISHING METHODS - AN IMPORTANT TOOL FOR FISH CONSERVATION AND MANAGEMENT A CASE STUDY IN DOON VALLEY, UTTARANCHAL

*Devi. P Uniyal, * S. N. Bahuguna, Arun Kumar and ** Manisha B. Uniyal*

Zoological Survey of India, Northern Regional Station, 218, Kaulagarh Road, Dehradun, Uttaranchal
***Deptt. of Zoology, H.N.B. Garhwal University, Srinagar (Garhwal)**
****Deptt. of Environmental Studies, H.N.B. Garhwal University, Srinagar (Garhwal)**

Authors surveyed the entire Doon Valley (Eastern and Western) for more than three years and observed that the study of fishing methods play an important role for the fish conservation and management. The fishing methods observed have been classified into two parts *viz.* (i) Scientific fishing methods - means collection of required number and size of fish so that sufficient population of fish remain balance in the nature (ii) Unscientific fishing methods - means indiscriminating killing of large number of fish (juvenile as well as brood fish) which adversely affects the water quality of rivers. A total of 21 fishing methods have been observed in Doon Valley of which 15 were scientific methods *i.e.* (1) Pattari (2) Cast net (3) Scoop Net (4) Angling (5) Side water diversion (6) Mosquito net (7) Hand Picking (8) Gowda trap (9) Patti net (10) Katori (11) Fundi (12) Bori (13) Jali (14) Char (15) Jail-fundi . While six were unscientific methods i.e. (1) Dynamating (2) Electric current (3) Hammering (4) Ichthyotoxic Plants (5) Bleaching Powder and (6) Night Fishing.

It is important to study the fishing methods of concern area before starting any new project and making fishery policies, as it gives clear-cut picture regarding the anthropogenic pressure on concern rivers. If more unscientific methods were reported from concern river then it will face more pressure, scarcity / indiscriminate killing of fishes, aquatic fauna and water pollution. For the effective fish conservation and management in Uttaranchal before taking any new projects in particular river the fishing

C - CONSERVATION & RESOURCE MANAGEMENT

C-1

BIOCHEMICAL STUDY OF LIVER AND GONAD OF FRESHWATER MIGRATORY FISH, *TOR PUTITORA* (HAM.) DURING PRE-MIGRATORY AND MIGRATORY PHASES IN THE GANGA RIVER SYSTEM

S.N. Bahuguna, Anup Raj and Hemant Joshi

Histo-chemistry, Biochemistry & Fish breeding Lab,
Department of Zoology (UGC-SAP) HNB Garhwal University Srinagar,
P.B. No. 70, Garhwal-246 174, Uttranchal

In fresh water migratory fish-*Tor putiotora* (Ham.), biochemical study was done for the estimation of protein and lipid values from the liver and gonad during pre-migratory phase and migratory phase on mature female fish. Fish sample was collected from the Ganga river during April-May (pre-migratory phase) and its tributaries (Saung river Dehradun and Eastern-Western Nayar from Satpuli) during July- August in migratory phase.

Quantitatively, a marked variation was obtained in biochemical components during migratory phase. Biochemical estimation of liver shows that the values of protein and lipid contents decreased as the migration started. During pre-migratory phase, protein was estimated to be 17.21 ± 14.20 mg/g and in migratory phase, it was recorded 148.68 mg/g. Lipid content decreased from 82.69 ± 13.71 mg/g during pre-migratory phase while it increased in migratory phase and was recorded to be 218.48 ± 15.09 mg/g. As the fish started migration, lipid content increased and estimated 40.46 ± 5.72 and 59.53 ± 4.50 mg/g in pre-migratory and migratory phases respectively. This remarkable quantitative change in protein and lipid contents of liver and gonad shows that the fish

C-2

ALTITUDINAL VARIATIONS IN DIVERSITY OF BENTHIC DIATOMS IN THE MOUNTAIN STREAMS

Prakash Nautiyal and R. Nautiyal***

***Department of Zoology, University of Allahabad, Allahabad -211 002 (U.P)**
***Department of Zoology, Govt. Degree College, Talwari-Tharali, Chamoli Garhwal (Uttaranchal)**

Mountains present a unique variety of habitats due to difference in elevation. Information on the diversity of diatoms in mountain lotic systems which traverse from high to low elevations, especially the Himalaya, is scarce. The focus of present studies was to understand the influence of altitude on the taxonomic diversity of epilithic diatom community in the Mandakini basin. This basin is sandwiched between the Bhagirathi and the Alaknanda basins which give rise to mountain rivers forming River Ganga. The basin has unique vegetation and elevation increase from 600m to >3000 m above msl within 70 kms of road distance. The Mandakini basin with an area of 1648 km^2 located between latitude 30^0 17' to 30^0 49' North and longitude 78^0 49' to 79^0 22' East. In the Mandakini basin, a large part (48.8%)of the land is under forest cover The remaining land is either under cultivation (14.2%), wasteland (36.9%) or under perpetual snow (5.6%). Eighteen streams were sampled in this basin. The streams have been described here in the ascending order *i.e.* upstream of Rudraprayag to Kund and from Kund towards Kedarnath on one hand and from Kund towards Tungnath on the other. A large number of streams were sampled at low, middle and high elevations. The Pine Forest streams of low elevation (PF-SLE) between Rudraprayag and Kund included Rampur (rm), Banswara (bw), Kakra (kk), Rawan (rw) and Mandakini at Kund (k-m). These are left hand tributaries of the Mandakini. The Mixed forest (Kanchula, Banj Oak, *R. arboreum*, *Alnus nepalensis*) streams of middle elevation (MF-SME1) between Kund and Soneprayag included Byung (bg), Sitapur (si), Kaidung (Ki), Gabani (gb), Sone (so) and Mandakini at Soneprayag (s-m). These are right-hand tributaries of the Mandakini. The mixed forest (dominated by Banj Oak-*R. arboreum*, *Alnus nepalensis*) streams of mid-altitude forest (MFSME2) between Kund and Pothibasa included Deoria brook (bd) and Mastura (ms), while the Kharsu Oak-*R. campanulatum*-Spruce-Fir

This however, was a trend not a rule because there were pockets causing fluctuations. In the Mandakini basin, the Shannon diversity for the diatom community was, < 3 in the SHE and >3 in the SME and SLE. Like Shannon diversity, the mean species richness and evenness also increased from SHE to SLE (with decreasing altitude). Notably, S tended to be exceptionally similar among the streams of SME1 (26 taxa). However, among the streams of each elevation, these parameters exhibited a peak and a fall. Consequently, a bi-humped profile was observed for S and E while a tri-humped profile for H in SLE, SME and SHE. On this basis, centers of diversity were identified in each zone [SLE, SME, SHE]. In SLE, the Rampur Gad. All SME1 were equally rich. However, the Byung Gad was relatively more diverse and even. In SME2, the Deoria brook was rich. In SHE, the Pothibas Gad exhibited higher richness, while diversity and evenness was high in the Akashkamini. It can be concluded that

1. Hildrew and Townsend's (1987), intermediate levels of disturbance under conditions of high productivity
2. Minshall's (1988) intermediate levels of stability and hardness
3. Krebs (1994) moderate amount of 'disturbance'
4. Botkin and Killerr's (2000)
    i. Physically diverse habitat
    ii. Moderate amount of disturbance , fire, storm, sudden flow of water (from a storm)
    iii. A small variation in environmental conditions (temperature, precipitation, nutrient supply)

These are the factors of consequence for diatom biodiversity in the mountain streams of the Mandakini basin. Of these factors, hardness especially, can account for low diversity in SHE, while fronts of abrupt change, intermediate levels of disturbance, hardness, physically diverse habitat, moderate amount of disturbance (fire common in Pine forests, sudden flow of water from a storm in monsoon) and a small variation in environmental conditions (temperature, precipitation, nutrient supply, which happens temporally) can account for high levels of diversity in SLE.

C-3

HABITAT PREFERENCE OF HILL STREAM FISHES OF WESTERN HIMALAYA

M.S. Johal
Fish & Fisheries Laboratory, Department of Zoology,
Punjab University, Chandigarh

The habitat preference of 41 hill stream fish species inhabiting 48 hill streams of the rivers Beas, Sutlej, Ravi, Ghaggar, Yamuna and Ganga of Western Himalayas has been studied. Four types of streams *viz.* A, B, C and F type have been identified . "B" type streams support maximum abundance and fish diversity. Out of seven rivers, the hillstreams of the river Beas provide varied type of habitats hence there is maximum fish diversity in this river.

Four type of habitats *viz.* pool, runs riffles and rapids have been recognized. Most of the fish species prefer pool habitat followed by rapids and riffles. None of the fish species has preference for run habitat but the presence of most of fish species has been recorded.

In addition to type of streams, the habitat, the geomorphology of the substratum, altitude, water temperature, turbidity, conductivity, total dissolved solids, alkalinity and total hardness also play an important role in species richness.

Four indicator fish species *viz.*, *Tor putitora*, *Schizothorax richardsonii*, *Barilius bendelisis* and *Garra gotyla gotyla* have been recognized at various altitudes in the streams whereas other fish species support the community structure. *Oncorhynchus myskiss* and *Salmo trutta fario* have been introduced in the upper reaches of Himalayas and do not constitute any fish community.

C-4

BIODIVERSITY THREAT TO MAHSEER FISH OF NARMADA BASIN, M.P: "CONSERVE IT"

Nishi Naryani and Praveen Tamot

M.P Council of Science & Technology
Vigyan Bhawan, MACT Campus, Nehru Nagar, Bhopal

Mahseer is one of the most important game fish of India. The fish constitute one of the major protein source for human around the world. The fish communities and their natural habitats have always been under various threats and disturbances due to both natural and manmade interventions. The threats are due to habitat alteration brought about by construction of dams, illegal fishing, indiscriminate exploitation of juveniles, habitat destruction, sewage and industrial pollution, wanton destruction, soil erosion, introduction of exotic species and agricultural operations prevailing in catchment areas.

Madhya Pradesh is a land-locked state of India having the Vindhyas and Satpura mountain ranges. The state is transgressed with 20,661 km stretch of 7 rivers and their tributaries. River Narmada originating from hills of Amarkantaka in district Shahdol of Madhya Pradesh has a stretch of 1280 km draining through 3 states-Madhya Pradesh, Maharashtra and Gujrat in between Vindhyas and Satpura mountains. About 84% of river stretch (1077 km) falls in Madhya Pradsh covering 7 districts (Shahdol, Mandla, Jabalpur, Narasingpur, Hoshangabad, Khandwa and Khargone).

Earlier three species were recorded from the river systems of the state *viz. Tor tor, Tor khudree and Tor putitora*. Now a days, among the three species of mahseer, *Tor tor* appears to be widely spread in the state. River Narmada joins the largest drainage system of the state and the mahseer (*Tor tor*) is predominant in total fishery. Thus, large impacts of mahseer fish biodiversity declines are much serious than we presently know and are yet to be visualised and estimated.

C-5

CAUSES OF FISH DWINDLEMENT IN KASHMIR AQUATIC ECOSYSTEMS

A. Wanganeo and R. Wanganeo***

***Department of Limnology, Barkatullah University, Bhopal, M.P**
****Department of Zoology, S.V. College Bairagarh, Bhopal, M.P**

Kashmir valley lies within four mountainous ranges. Towards the NE lies the great himalayan range, Saribal range lies towards the SE of the Valley while Pir Panjal range lies towards the SW side of the valley. Towards the NW side lies the Kaznag range.

River Jhelum traverses all along the valley flowing from SE to NW direction, enroute various tributries meet it. Lidder stream meets it close to its origin from the east in southern half of the valley emanating among the upper Karewa beds while Vishav and Rimbiara streams meet it from the SW side, emanating from both upper and lower Karewa beds. River Sindh emanating through Karewa beds meet river Jhelum in the northern half of the valley. Besides there are good number of both perennial and ephemeral streams that meet river Jhelum during its course through the valley.

Such a network of streams present in predominantly temperate climate (extending from subtropical warm and dry via warm temperate and wet to cool temperate and moist to dry climate which as per experts has come into existence 4 million years ago) supports a good number of both flora and fauna.

Palynological study on Kashmir valley records around 60% of diatoms having a wide temporal range stretching from Oligocene to the Holocene and are indicative of freshwater conditions. The different types of upheavals in the valley have affected varyingly the growth of valley. Almost every aspect has recorded a considerable change. Present paper throws light on how the anthropogenic activities besides the natural changes have been responsible for bringing about a massive change in the fish population of both the lotic and lentic habitats of almost all trophic status in Kashmir valley.

The change in land use and land cover patterns alongwith the over- exploitation

for such a dwindlement of the fishes are as:

1. Geological upheavals
2. Tourist influx
3. Game/sport fishery
4. Over- exploitation of resources

Tectonic movements have been found to be responsible for segregation/isolation of fish species as is evident from the presence of *Diptychus maculatus* (belonging to subfamily Schizothoracinae) from only two high mountain lakes in Kashmir.

Tourist influx has resulted in ecological damage, mainly in camping areas near lakes and streams, in the form of soil compaction - vegetation destruction (stopping seed germination resulting in denudation of natural vegetation cover). This in turn has enhanced the siltation from both the riparian as well as the total catchment area thus spoiling the fish breeding grounds.

Though game fisheries is a source of economy and strengthens tourism and makes outing more enjoyable for users interested in fishing yet it has been found to cause more harm to the fisheries. Though permit system was developed with the idea of controlling use to alleviate pressure on the stressed areas but its compliance has not been more than 25% that, too, in the reserve areas and it did not appear that the present system would be effective in achieving the desired results. To start with, aerial planting of trout fingerlings was carried out in the high mountain lakes which later flourished but due to high angling pressure and no recruitment policy had led to the dwindlement of trout fishery in the lakes situated at 3000 m asl.

Over- exploitation of the resources has also led to the decline in the fish population as well as fish production. During 1978, *Schizothorax niger* has been found to spawn within the Dal lake, the said fish was found to have declined to an alarming rate during nineties, the reason being high anthropogenic pressure.

These Himalayan ecosystems invite immediate attention to take up conservation/ rehabilitation measures at war footing before the gene pool of aquatic recourses is lost. The fact that aquatic ecosystems go hand in hand with terrestrial ecosystems needs to be emphasized in order to develop a meaningful long lasting conservation strategy.

C-6

FISHERY RESOURCES OF RIVER YAMUNA IN HIMALAYAS

*Usha Moza, D.N. Mishra and A. Hajra**

Karnal Research Centre of CICFRI, Karnal-132001, Haryana
***Central Inland Capture Fisheires Research Institute,**
Barrackpore, West Bengal.

Himalayan zone of Yamuna extends from Yamunotri to Hathnikund/Tajewallah covering a distance of 172 km. Fishes are known to be preset in this river from Naugoan (Distt. Uttarkashi of Uttaranchal state) onwards but commercial exploitation of this resource takes place from Kalsi (junction of Tons and Yamunotri) onwards. In present communication, fishery resources of mountainous Yamuna covering an approximate distance of 72 km from Kalsi (where Yamuna leaves Greater Himalayas) to Hathnikund (where Yamuna leaves Sivalik Himalayas) are being dealt with.

Distribution of fishery within the stretch can be categorized into 3 zones as per altitude and water temperature.

i) Resource above the altitude of 458 m asl having an average water temperature of 18°C extending from Kalsi to Dakpathar, an appropriate length of 7 km is snow- trout zone and harbours mostly *Schizothorax richardsonii* (50%). Other fishes present are *Garra* (2 spp.), *Glyptothorax* (2 spp.) *Tor* (2 spp.) and *Bagarius bagarius*. The exploitation is low key. 8-10 local fishermen are involved permanently. Average catch / day ranges between 1-20 kg during winter and nil-10 kg during summer. The produce is disposed off mainly at Haripur market.

ii) Resources below 458 m asl, from down Dakpathar barrage to Kulal roughly 30 km stretch having an average water temperature of 20°C, encompassing the junction of Giri and Asan tributaries with Yamuna, is mahseer zone. The fishery is dominated by mahseer, *T. putitora* mainly (41%). The area harbours diverse fish fauna like major carps, *L. calbasu* and *C. mrigala*, minor carps like *L.*

35 kg/day during post-monsoon to 20-25 kg/day during winter. The produce is disposed off at Kulal landing centre situated on Yamuna bridge connecting Dehradun (Uttaranchal) with Ponta Sahib (H.P.).

iii) Resources below Ponta weir to Hathnikund barrage, 348 m asl having an average water temperature of 21.6°C, the zone harbours both mahseer (26.11%) and kalbasu (27.94%) fishery. The other fishes present are minor carps, *L. dero*, *L. dyocheilus*, *L. gonius*, *L. bata*; cat fish, *W. attu*; trash fish, *C. bacaila*, *Puntius sophore*. The fishing is low key because of steep gradient along Kelasar. The produce is consumed either locally or sold at Faizabad station (U.P.)

C-7

STUDIES ON NATIVE ORNAMENTAL LOACHES OF NEH STATES WITH A NOTE ON THEIR CONSERVATION

B.K. Mahapatra, K. Vinod and B.K. Mandal

Division of Fisheries, ICAR Research Complex for NEH Region, Umiam,(Barapani) 793103 Meghalaya

The members of the families Balitoridae and Cobitidae are popularly known as Loaches.The loaches form an important group having good potential as aquarium fish due to their small size, bright bands,blotches, colouration, peaceful nature, hardiness and compatibility. The North Eastern region of India comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram , Nagaland, Sikkim and Tripura receive heavy rainfall. They have rich fishery resources in the form of rivers, flood plain wetlands (beels), lakes, reservoirs, ponds and mini-barrages as well as low-laying areas suitable for paddy cum fish culture system. The region presents diverse topographical conditions ranging from the plains of Brahmaputra and break valleys in Assam, high flat lands of Imphal valleys in Manipur to predominantly hilly/mountainous regions of Meghalaya and Mizoram. The diversified fresh water resources of the region harbours as many as 270 fish species, which is approximately 33.5 % of the total Indian freshwater fishes. Studies indicated that out of 270 fish species from the eight North-Eastern Hill states, there are 45 loach species belonging to 15 genera. The state- wise distribution of the different loaches is presented. Among 45 potential loaches, 10 species are already popular among the traders and hobbyists both locally and globally by specific trade name. These loaches are exported mainly to USA, UK, Japan, Singapore, Bangkok, Taiwan through 14 exporters based in Kolkata. Although the trade is not organized but the fishes are collected from the natural habitats by local fisherfolk and are sent to Kolkata by some traders. These fish species have increasing demand in the overseas market, as importers all over the world are eager to find supplies of uncommon and new species of ornamental fish to keep with the demand of most sophisticated hobbyists. Although its price at the collection site is very nominal,

most of the species have become endangered and even some of them are very rare in NEH region. Therefore, proper strategy for the conservation of these uncustomary biotic resources, especially the endangered and threatened species, is needed. Different stakeholders engaged in this trade can help in different ways to protect the fish in a networking manner. Following suggestions will be conducive to the sustainability of ornamental fishery.

1) With proper education and technical guidance, local fisherfolk can be trained to sustainable exploitation of these ornamental fishes in which sufficient tracts of their natural habitat including their breeding grounds are conserved.
2) Harvesting can be encouraged only in the "Population collapse" phase not in the "growing" phase.
3) The feeding and breeding biology including natural behavior of various fish species should be studied for proper utilization.
4) For stock enhancement, fishermen and culturists should adopt the captive breeding process.
5) Export should be made keeping in mind the conservation of gene pool of the indigenous fish.

C-8

SIZE AND AGE RELATED VARIATIONS IN DIETARY HABIT, ITS OVERLAP AND PREFERENCES OF *TOR PUTITORA* (HAMILTON) IN THE RIVER GANGA AND ITS TRIBUTARIES IN GARHWAL REGION

Bijay Kishor Bahuguna and Prakash Nautiyal***

***Department of Zoology**
H.N.B. Garhwal University, Srinagar -246174 (Garhwal), Uttaranchal
****Department of Zoology, University of Allahabad , Allahabad - 211001**

The population of *Tor putitora* is dispersed in the Ganga, a little downstream of Hardwar and its upstream tributaries the Saung, Nayar and Alaknanda. The Nayar and Saung are spring fed, carrying warm waters (Nayar 13-32^0 C; Saung17-25.5^0 C) as compared with the glacier fed Ganga, a coldwater body (15-23^0 C). Water temperature, velocity, DO and density of benthic community were found to differ significantly ($P<0.05$) among the Ganga, Saung, Nayar and Alaknanda. The smaller size group of golden mahseer (< 280 mm) were common round the year in the Nayar and Saung, while larger (> 280 mm) in the Ganga. In the Alaknanda, their presence was seasonal. In 10-70 mm size, both the animal and plant components constituting <50% of diet annually formed 'Basic' food while debris was its 'secondary' food. Fish <70 mm size were hence, omnivorous while those measuring 70-100 mm size was carni-omnivorous in the Nayar and carnivorous in the Saung . The size 40-70 mm owing to slight dominance of plant component was called herbi-omnivorous. The 100-190 mm size was carnivorous both in the Nayar and Saung. The 190-520 mm size was carni-omnivorous by habit but in the Saung, the content of organic debris (5-48%) was higher than the Nayar, especially in 220-250 mm size. In the juveniles (100-190 mm) of the Ganga, insects comprising >80% of diet annually, constituted the 'basic food', while the algae was the 'secondary food' as observed in 70-100 mm size and was categorised as carnivorous. In 190-520 mm and >520 mm size was also carnivorous with insect as 'basic food' but the share of plant food increased with increasing size. Piscivourous tendency was observed in < 460 mm size. The feeding intensity decreased with increasing size and intensity was [illegible] Nayar and Saung as compared with the Ganga sample. In fish below 100

which declined with size. Overlap in diet was high among <100 and 190 mm size in the Saung and Nayar. The <190 and < 520 mm size exhibited more overlap in the Ganga. *T. putitora* exhibited positive preference/selection for all insect groups while negative for diatoms. The other algae showed positive as well as negative preference. The pattern of preference was similar in the larval, juvenile, adolescent and adult stages in all the streams and rivers.

C-9

STATUS OF TROUT FISHERY IN UTTARANCHAL

S. R. Chanyal, R.C. Pokhriyal and L.M. Joshi*

***Directorate of Fisheries,**
2, Turner Road, Clementown Dehradun, Uttaranchal
State Fisheries Department,
Kathgodam (District Nainital), Uttaranchal

The Uttranchal state which came in existence on 9th November 2000 by the division of Uttar Pradesh, comprise 13 districts, of which Nainital, Almora, Pithoragarh, Champawat, Udhamsinghnagar and Bageshwar in Kumaon mandal and Chamoli, Uttarkashi, Tehri, Rudherprayag , Dehradun, Haridwar and Pauri are in Garhwal mandal. The Himalayan natural fluvial waters differ significantly in their morphology, physical and chemical properties and the biological populations. The water resources are available in the form of important fast flowing cold water streams/ rivers with their tributaries and natural lakes. The dominant fish species of such high altitude water is snow trout (*Schizothorax richardsonii*). The non- availability of important game fishes in high altitude lotic and lentic waters created interest of Britishers to stock them with trout, the world famous game fish for their recreation. Fisheries department with its limited technical and financial resources is trying to create infrastructure facilities for the production of stocking material in order to increase the trout population in streams and upland lakes. Trout is established in few rivers/streams of Garhwal region like Pinder, Tons, Asiganga and Balkhila. In the hill region of Uttranchal, vast potentials are available for the development of suitable and economically important fish fauna besides trout.

The present communications deals with the historical background, present status and future programme for the development of trout fishery in Uttaranchal.

C-10

INFLUENCE OF TEHRI DAM CONSTRUCTION ON BIOMASS, GROWTH AND PRODUCTION OF A HIMALAYAN CYPRINID *TOR PUTITORA* (HAMILTON)

Ramesh C. Sharma

Department of Environmental Sciences,
P.O. Box 67, H.N.B. Garhwal University,
Srinagar- 246 174, Garhwal (Uttaranchal)

The influence of construction activities of Asia's biggest dam -the Tehri dam on biomass, growth and production of a himalayan cyprinid, *Tor putitora* was undertaken over a four year period (November 1993-October 1997). The maximum means biomass (B) of *Tor putitora* (0.492 gm^{-2}) estimated in February at the reference site reduced to 0.185 gm^{-2} after receiving the detrimental effect at the impacted site. The annual production of the himalayan cyprinid (*Tor putitora*) which was estimated to be 0.198 gm^{-2} y^{-1} at the reference site reduced sharply to 0.54 gm^{-2} yr^{-1} at the impacted site over a four year period. An interesting inference was also derived out of the data analysis on mahseer production and its growth pattern that the environmental variables (abiotic and biotic) dominates over the density dependent processes in regulating the mahseer growth.

C-11

COMPUTERIZED DATABASE FOR FISHERY RESOURCE SURVEY IN UTTARANCHAL

Ashok K. Nayak and K.K. Vass

National Research Centre on Coldwater Fisheries, Bhimtal 263136 Uttaranchal

The Uttaranchal was constituted, as the 27th state of the Indian Republic on 9th Nov. 2000 comprises 13 districts. The state contains more than 80% of the mountain region. The nature has endowed this state with lakes and rivers. The water bodies can be used for fisheries purpose, so there is a need for conducting a survey to find out the resources for fisheries development in this state. A computerized database format has been designed and for conducting the survey. After collating the data, it can be fed to computer to make a fully computerized database on fishery resources, available in the Uttaranchal State. As this was a newly constituted state, the computerized database will help in planning.

This computerized database contains many formats for entering the data regarding availability of lakes, reservoirs, ponds, rivers etc. Their physical parameters, ecological parameters as well as the availability of biotic species are also to be inserted. There is a provision for entering the data related to developing a fish farm at the particular place. The database also contains the information regarding the availability of hatchery and water supply.

C-12

SEASONAL HISTOLOGICAL CHANGES IN THE TESTES OF A HILL STREAM CARP, *GARRA NASUTA* (McCLELLAND) IN RELATION TO CERTAIN ABIOTIC FACTORS IN THE BASISTHA RIVER OF ASSAM

Purnima Das

Department of Zoology
Dhing College, Nowgong (Assam)

The study of morphological and histological features of the testes throughout the year yields positive clue to divide the annual testicular cycle of *Garra nasuta* into four well marked spawning phases *viz.* Preparatory phase (November to January), prespawning phase (February to April), spawning phase (May to July) and post spawning phase (August to October).

During the preparatory phase the testes tend to increase marginally in their weight and volume. The testicular lobule possesses a good number of primary and secondary spermatogonia. During the prespawning phase, the testes attain their maximum development and maturity as is evident from the highest weight and lobulated structure. The lobules attain maximum size containing sperm mother cells, primary and secondary spermatocytes and spermatozoa. Thin interlobular septa contain interstitial cells. The testes attain their maximum weight and volume during spawning phase. Active spermatogenesis was observed and the seminiferous tubules are found to be filled up with spermatozoa. Light hours are found to be longest during this period of the year. Air and water temperature attain their peak value. pH of water was found to fluctuate from slightly acidic to slightly alkaline. Dissolved oxygen content showed wide fluctuations and recorded their lowest value of the entire period. The testes appear flaccid, thin and slender during post spawning phase. The testes show less activity and are found to be regressed. Sertoli cells and resting spermatogonia are observed. During this period, light hours show a decreasing trend. Water becomes less turbid. Dissolved oxygen tends to increase marginally.

C-13

AN APPRAISAL OF MAHSEER FISHERY IN RIVER SARYU OF KUMAON HIMALAYAN REGION

A.U. Khan, P. Sanga, Shyam Sunder and C. B. Joshi

National Research Centre on Coldwater Fisheries, Bhimtal- 263 136, Distt. Nainital (Uttaranchal))

River Saryu is one of the largest tributaries of the Kali river system. It originates from Nandakot massif in the central Kumaon himalaya and flows from north to south and then takes a turn in southeasterly direction before joining R. Kali at Pancheshwer. River Saryu and its network of tributaries are fed by springs emanating from underground waters. The overall anthropogenic and environmental stresses have affected the watercourse and brought about certain changes in the aquatic environment. As a result, the biotic communities inhibiting therein have been thinned out and a marked depletion has been observed. The fish stocks inhabiting in system, too, have subjected to a change in their population structure and many of them especially the famous golden mahseer has been showing declining trends rendering rejuvenation of its fishery. Catch composition of *Tor putitora* as revealed through experimental fishing ranged between 7.47-74.65% (27.16%) in the Saryu river system with a size and weight range of 80-350 mm and 3-400 g. The CPUE values of golden mahseer ranged between 45-487 g/man hr. (200 g/man hr.) Based on the catch structure and small size of mahseer, it is imperative to investigate in detail the biological and other environmental factors in the system. The result arrived at are presented in the paper.

C-14

TRAIT ENUMERATION IN ENDANGERED UPLAND GOLDEN MAHSEER, *TOR PUTITORA* (HAMILTON 1822) FROM DIFFERENT HABITATS FOR GENETIC UPGRADATION

A.K.Singh, K.D.Joshi and Rajeev Kapila

NRC on Coldwater Fisheries
Bhimtal -263136, Nainital (Uttaranchal)

A study was conducted to enumerate the reproductive traits of *Tor putitora* under lacustrine and riverine environments. Results of this study delineated variation in morphometric and morphomeristic characters such as sex ratio and reproductive parameters, which included fecundity, ova diameter, broodfish size etc. We have recorded fecundity in mahseer from lacustrine as well as riverine environment. The mature ova counted was 600 to 6100 per individual of stripped females (47 Nos.) ranging 360-450 mm/365-800 g from lacustrine environment whereas in riverine environment (Garhwal rivers), the fecundity ranged from 7076-18525 eggs in 339 to 517 mm length of fish. The ova size at different stages of maturing ovary ranged 0.016 to 3.026 mm in lacustine environment while it varied from 0.018 to 3.228 mm in riverine environment. The size of newly hatched juveniles ranged between 5.4 to 8.5 mm in comparison of the size of the fertilized eggs (2.6-3.8 mm) in different environment of lakes and rivers respectively.

Data on sex ratio in mahseer (*Tor putitora*) in nature has been scanty. The sex ratio variation is more in lacustrine environment and has been observed to be 1:5 for female versus males. Mahseer caught from Garhwal rivers by gill nets showed 3 males for one female in different catches. Sexual maturity is first achieved by males during third autumn (2+ year) and females at about four years in rivers while it is more in case of lacustrine environment. Males are caught in greater numbers in nights than during daytime. It is therefore important to identify the ecological significant units (ESU) to conserve the diversity of this mighty fish under different environments. It is apprehended that some of the superior trait among the populations (lacustrine and riverine) may have evolved through adaptation to local environment which needs

C-15

ECOLOGY AND FISHERIES OF SELECTED COLDWATER STREAMS OF ASSAM

B. K. Bhattacharjya, M. Chaudhury, V. V. Sugunan, V. Pathak** and A. Sarkar*

Northeast Regional Centre (CICFRI),
Housefed Complex, Dispur- 781 006 (Guwahati)
***Central Inland Capture Fisheries Research Institute,**
Barrackpore- 743 101 (W. B)
**** Riverine Division, Central Inland Capture Fisheries Research Institute,**
24- Pannalal Road, Allahabad - 211 002 (U.P)

Assam, the second largest state of northeast region of India covering an area of 78,438 km2 is situated in the eastern himalayan region (Lat. 24° & 28°18' N Long. 89°50' & 97°40'E). The sub-himalayan mountain ranges of Bhutan and Arunachal Pradesh and the hills of Nagalad, Meghalaya and Mizoram surround the state. These hills and mountains give rise to many fast flowing streams down the gradient and ultimately joining the Brahmaputra and the Barak rivers. The river Brahmaputa alone has 42 important tributaries in the state- 27 on north bank and 15 on the south bank. These rivers which criss-cross the Brahmaputra and Barak valleys, support a rich variety of freshwater fishes, many of which are commercially important. However, barring a few studies on river Brahmaputra and few important tributaries no studies have been conducted in coldwater streams of Assam. In view of the above studies on ecology and fisheries of selected coldwater Central Inland Capture Fisheries Research Institute conducted streams of the state during 1996-98.Soil, water and biota samples were collected from 9 potential coldwater streams of the state viz. Subansiri, Ranganadi, Borgung, Jiabharali, Manas Beki, Lohit, Kapili and Tulsi and analyzed in the laboratory using standard methods.

Soil of the selected streams had sandy texture (87.5-98.5%), acidic to alkaline pH (6.5-7.5), low organic carbon (0.12-0.46%), moderate available Nitrogen (6.04-21.12 mg/100g) and moderate available Phosphorus (0.28-1.78 mg/100g). Lohit, Beki

dissolve solids (24.9-173.8 mg/l) fluctuated widely amongst the rivers. The rivers recorded moderate levels of Nitrate-Nitrogen (0.014-0.026 mg/l) and Phosphate -phosphorus (0.004-0.010 mg/l) while silicate-silica levels were high (4.3-6.8 mg/l).

Plankton population was low (34 to 177 u/l) in selected rivers except in river Borgung were a considerably higher population (753 u/l) was recorded .Phytoplankton overwhelmingly dominated the plankton population in all the rivers and zooplankton was recorded only in Subansiri (4 u/l),Borgung (20 u/l) and Manas rivers (11 u/l).Phytoplankton population was dominated by Bacillariophyceae in all the rivers except in river Subansiri where chlorophyceae was the dominant group. Zooplankton population was dominated by copepods, in Borgung and Manas river whereas in Subansiri river rotifers dominated. Macrobenthic fauna was dominated by chironomids in most of the streams followed by gastropods, insects, oligochaets, and bivalves. The net primary productivity of phytoplankton was estimated to be in the range of 178.4-314.4 mg cm^{-2} d^{-1} in Jiabharali, Subansiri, Lohit and Manas rivers. Fish production potential estimations based on primary productivity in these four rivers ranged from 61 (R Jiabharali) to 107 kg/ha /yr. (R Manas). Important coldwater sport fishes recorded in the selected rivers were mahseers (*Tor putitora,T. tor, T. progenius, T. mosal),* Bokar/Katli *(Neolissocheilus hexagonolepis, N. hexastichus),* snow-trouts *(Schizothorax richardsonii, Schizothoraichthys progastus)* and Indian trout *(Raimas bola).*The upper stetches of Jiabharali near Balipara (under Nameri Resrve Forest) in Sonitpur district and R. Kopali near Umrangshu (N.C. hills district) were found to be favourite angling spots. River Jiabharali has become the most famous eco-tourism center of the state where Assam Bhorali Anglers Associations organizes angling competitions every year during the winter season. The upper stretch of R. Manas located within the Manas Wildlife Sanctuary in lower Assam was a good angling destination earlier. It has lost its importance temporarily in recent years due to insurgency problem. The potential of R. Kulsi and R. Borgung as possible sport fisheries has been known for a while. In addition, the present study indicated that R. Lohit (upto Alubarighat in neighbouring Arunachal Pradesh) , R. Subansirim R. Ranga nadi (Lakhimpur district) and R. Beki (Barpeta district) have the potential to be developed into very good sport fishery/ eco-tourism centres. In addition to sport fishes, these rivers harboured a good number of commercially important food fishes like *Labeo dyocheilus, L. dero, Barilius shacra, B. bendelisis, B. barila, B. barna, B. vagra, Nangra nangra, N. assamensis* and *Amblyceps mangois.* The peak-fishing season in all these rivers was observed to be from October to December when coldwater fishes migrated downstream from the mountains/ hills of Bhutan, Arunachal Pradesh and Meghalaya. In addition *Barilius* spp. and *Nangra* spp. also have potential ornamental value.

C-16

JAGI ROAD DRY FISH MARKET OF NORTH EAST HILL REGION : PROSPECTS AND POTENTIALS

M.M.Prasad, Prem Kumar and J.K.Bandhopadhyay

Burla Research Centre of CIFT, Burla-768017, Sambalpur (Orissa)

Jagi Road dry fish market in naogaon district, Assam, is one of the largest of its kind in Asia, playing an important role in catering to the much needed protein requirements of north east hill states viz. Assam Arunachal Pradesh, Manipur,Meghalaya ,Mizoram,Nagaland and Tripura.The dry fish constitute major animal protein for economically unprivileged people, especially those engaged in tea states ,agriculture and the residents of hinterlands.

While the freshwater fish comes mainly from West Bengal, Andhra Pradesh and Uttar Pradesh and the marine fish come from Gujarat Maharashra, Tamil Nadu, Andhra Pradesh and Kerala. Gujarat ranks first in export of marine fish to this market. In the peak season *i.e.* September to March, nearly 30 truckloads of dry fish per week, each truck carrying 12 to 15 tonnes are unloaded into the market. The most common varieties are Bombay duck, ribbon fish, croackers, perches, lesser sardines, anchovies, sharks, tiny prawns (Acetes and prapaenaeopsis) etc.

Some of the dry fish is further bioprocessed and is consumed as fermented fish product which is considered as delicacy in the NEH region .The method of fermentation is a traditional one and no data is available on physical, microbiological and biochemical qualities of the product. The Burla Research Center of CIFT has taken up research project to carryout quality analyses extending the keeping quality of the product and standardizes the method of preparation of the product.

The glut and by-catches landed in major landing centers of maritime states does not fetch proper return to the fishers. The catches that are dried in open areas in the vicinities of the landing canters ore blow fly infested, generate fowl smell and are used as poultry feed or for preparation fish meal. However, these catches, after sorting and fermenting for few days can be exported to NEH states that will only cater to nutritional requirements of the people but also generate sustainable income to fisher of the maritime states.

C-17

DEFORMITIES IN SOME ADULT SPECIMENS OF *ONCORHYNCHUS MYKISS* (WALBUM) FROM KOKERNAG TROUT FISH FARM, KASHMIR (J & K)

S.P.S. Dutta, N.A. Jan, J.P.S. Bali, S.C. Gupta and C. Koul

Deptt. of Env. Sciences, Univ. of Jammu, Jammu
*** Deptt. of Fisheries, J&K Govt. Srinagar**

Ten adult deformed specimens of *Oncorhynchus mykiss* were seen in fish collections at Kokernag Trout Fish Farm and have been described. Present study includes multiple anomalies (truncated body, absence of pectoral fins, absence of right pelvic fin, rudimentary left pelvic fin with reduced number of fin rays, deformed and irregular caudal fin, variable morphometric ratios, vertebral column, haemal spines, ribs and caudal skelton) truncated body (disposition of fins, variation in morphometric ratios, vertebral trough, fusion of vertebrae and reduction in intervertebral space, wavy and undemarcated neural and haemal spines and caudal skeleton abberations), one eyed blind fish, blind fish with degenerated pectoral fins, degenerated right pectoral fin and short opercular covering, pectoral fin deformities (total absence, absence of one pectoral fin, and partial degeneration of the other fin and unequal pectoral fins) and degenerated paired and unpaired fin rays . Fish anomalies in the present case are most probably due to injury and developmental errors.

C-18

COMPARATIVE KARYOMORPHOLOGY IN FOUR SPECIES OF MAHSEER

N. S. Nagpure, Satish K. Srivastava, M. S. Verma and Ravindra Kumar

National Bureau of Fish Genetic Resources
Canal Ring Road, Telibagh, P.O. Dilkusha, Lucknow - 226 002

Mahseer is one of the important endangered game and food fishes of India . These groups of fishes belong to family Cyprindae and so far six species and three subspecies have been reported in India belonging to genus *Tor*. Among these the two species *Tor putitora* (Ham.) and *T. tor* (Ham.) belong to Northen India while *T. khudree* (Sykes) and *T. mussullah* (Sykes) belong to peninsular India . Although some information is available on chromosomal profiles in these species but cvomparative studies are limited using karyomorphology and Ag-NOR banding . Further, location of Ag-NORs in *T. tor* has been yet reported. In view of the above, the present study was undertaken to differentiate these species on the basis of heteromorphic markers using conventional staining and Ag-NOR banding.

Live specimens (n = 5) of *T. putitora, T. tor, T. khudree* and *T. mussullah* were collected from Tata Electric Company fish farm, Lonavla. Fishes were administered intramuscularly with colchicine and kidney tissues were processed for chromosome preparations using hypotonic treatment-accetic methanol fixation - flame drying / air drying. Ag-NOR-banding was carried out . Karyotyping of Giemsa stained as well as banded chromosomes was done according to the classification proposed by Levan *etal.* (1964).

In the present study, although all species exhibited same diploid chromosome number of 2n=100, nevertheless, variation has been observed in their karyomorphology. The chromosome formula (CF) of *T. putitora* and *T. tor* was derived as 24m+24sm+28st+24t and 24m+36sm+24st+16t respectively while for *T. khudree* and *T. mussullah*, it was derived as 18m+16sm+44st+22t an 24m+24sm+24st+30t respectively. Ag-Nor banding of metaphase chromosomes revealed presence of multiple Ag-NORs [illegible] however, there was heteromorphism in number of NORs among these

C-19

APPLICATION OF MULTI-STAGE SAMPLING DESIGN IN ASSESSMENT OF FISH PRODUCTION FROM RIVERS AND STREAMS

R. A. Gupta and S. K. Mandal

Central Inland Fishries Research Institute, Barrackpore - 743 101

Natural fish stocks have ungergone considerable and sustained pressure from intense fishing, pollution and other anthropogenic activities conducted in and around rivers and streams. These activities have resulted in habitat loss and consequent decline in distribution and abundance of fish species . Fisheries management of these resources requires information on the levels of fish stocks and the extent of explloitation in order to suggest precise and effective management options to maintain the stock at sustainable levels.

Multi-stage sampling design has been widely used in fisheries sector particularly in marine fisheries for estimating fish production with reliable degree precision . But its use in inland fisheries is very limited due to lack of knowledge of appropriate survey methodology, suitable theoretical concepts and proper choice of sampling unit . This paper discusses the use of two-stage sampling design for estimation of fish production. At the first stage, a sample of stream sections of desirable length on the basis of natural habitat units is selected . At the second stagem sample nets are selected out of the total operating nets in each segment and fish catch is recorded for each selected net for estimation of production. The estimator of catch within each selected stream section is evolved on the basis of data recorded from commercial fishing.

Let N be the number of primary units of sizes M_i (i=1,2,3.....N) in the sampling universe and n be the number of primary units selected out of N . If Yi be the estimate of fish catch from i-th unit, then the fish production for the ith primary unit is expressed as follows.

$$\bar{y}_{ij} = \frac{1}{g_{ij}} \sum_{k=1}^{g_{ij}} y_{ijk} \quad \ldots\ldots\ldots\ldots (1)$$

$$\hat{y}_i = \frac{D_i}{d_i} \sum_{j=1}^{d_i} G_{ij} \bar{y}_{ij} \quad \ldots\ldots\ldots\ldots (3)$$

Where gij is the number of nets sampled on the j-th day in the i-th segment; Gij is the total number of nets operated on j-th day ; di is the number of sampled days during the month in the i-th segment ; Di is the total number of fishing days in the respective month. The above estimate will provide the fish yield from each selected segment.

Three estimators based on alternative two-stage designs with primary units of equal and unequal sizes have been developed for assessment of total fish production from the entire stretch. These estimators are expressed as follows :

$$\hat{y} = \frac{N}{n} \sum_{j=1}^{n} \hat{y}_i \quad \ldots\ldots\ldots\ldots (4)$$

$$\hat{y} = M_0 \frac{\sum_{n}^{n} y_i}{\sum_{n}^{n} M_i} \quad \ldots\ldots\ldots\ldots (5)$$

$$\hat{y} = \frac{1}{n} \sum_{}^{n} \frac{y_i}{p_i} \quad \ldots\ldots\ldots\ldots (6)$$

Where M_0 is the sum of M_i units over N ; p_i is the probability of selecting the i-th unit by pps with replacement.

A comparison of the performance of alternative two - stage designs have been made in terms of precision, relative cost and overall cost effectivenesss. This paper argues that the conventional method of selecting equal stretch lengths may not be appropriate and the unequal size of selected segments depending upon the stock units provides the better estimate of production with comparatively high degree of precision. [illegible] design is also presented based on the criteria

fish catch within selected section will usually be small but the errors of estimation at the first stage will be high resulting from extension of sampled sections to an entire stream. If segments are allowed to vary in size according to natural habitat units, the alternative two-stage sampling design may take advantage of the probable strong correlation between habitat until size and fish catch. When stream sections of unequal sizes are selected with probability proportional to size, or measures of sizes of selected sections are incorporated into estimators, one may substantially increase the precision of estimation. It was also concluded that the selection of design depends primarily on the correlation between fish catch and habitat unit sizes, on the total number of stream sections and sample size. It has also been observed that the use of an auxiliary variable (primary unit size) results in substantial improvements in the precision of estimates.

C-20

POPULATION DYNAMICS OF MAHSEER, *TOR PUTITORA* (HAM.) IN RELATION TO ITS CONSERVATION MEASURES IN GANGA RIVER SYSTEM AT RISHIKESH (GARHWAL HIMALAYA)

D. S. Malik and Kamal S. Negi

Department of Zoology & Environmental Science,
Gurukul Kangri University, Hardwar - 249 404, Uttaranchal

In the Ganga river system, the most exploited size of mahseer fish was 190 - 500 mm . The total catch were recorded to be high during summer 08-178 kg followed by 19-148 kg in winter and 12-92 kg in rainy season. Usually the catch of mahseer found to vary approximately 17-41% of the total catch. The result of length frequency of mahseer, *Tor Putitora* show that 190-460 mm size was dominant (25.50-44.16%) in total fish catch . The results have indicated that the 19-35 cm size of mahseer were caught before attaining sexual maturity. The Pashulok barrage on Ganga river near by I.D.P.L. township of Rishikesh also might have disrupted the breeding and migration habits of mahseer and consequently its population dynamics . The results also indicate the decreasing trends of mahseer population in Ganga river because the fish were killed without any production of young ones for next season. So it is necessary to check the declining trend of mahseer extinction by different conservation measures *viz.*, eco-convservation methods by improving the natural fish habitats, watershed protection, measures to minimize siltation and sedimentation, collection of stones, gravel and sand, etc.This has to be regulated in scientific manner so that the natural spawning grounds of the fish are not disturbed, poaching of destructive fishing practices should be prohibited, fishing during breeding season should be completely banned in the area and mass awareness programmes should be initiated amongst students, social workers, fishermen/ women, local people and create voluntary conservation groups to initiate fish conservation practices in their areas. At present, the main attention should be focused on restoration of natural fish habitats and different conservation measures for enhancement of populations of mahseer in Rishikesh region of Uttaranchal.

C-21

STRATEGIES FOR THE REGENERATION OF LAKE NAINITAL ECOSYSTEM

A. P. Sharma

Department of Fishery Hydrography,
College of Fishery Sciences,
G. B. Pant Univ. of Ag. & Tech., Pantnagar, Uttaranchal

Lake Nainital, one of the most picturesque lake in the world has become highly polluted during the past decades. The lake experiences mass mortality of fish every year. Vast areas of hypolimnion remain anoxic during major part of the year. The concentrations of nitrogen, phosphorus and ammonia have become very high. The blooms of green and blue green algae have become a permanent feature of the lake phytoplankton community. The unplanned introduction of some exotic fishes has greatly damaged the ecosystem of lake Nainital . The native fauna of the fishes has become almost extinct from the lake . The restoration of the lake ecosystem is therefore immediately warranted. The paper discusses various strategies involving physical, chemical and biological measures for regeneration of the lake ecosystem.

C-22

CONSERVATION AND MANAGEMENT PRIORITIES FOR FISHERIES DEVELOPMENT IN HIMALAYAS

C. B. Joshi

National Research Centre on Coldwater Fisheries
Bhimtal (Nainital)

With varied topography and different agro-climatic characteristics the Himalaya has tremendous potential for fisheries development with rich diversity of water resources in the form of rivers, streams and natural lakes. These aquatic resources once have been the abode for fishes like mahseers and snow-trouts are now under great stress due to anthropogenic pressure and natural causes. One of the distinct example in this context is lake Nainital in Uttaranchal, where fishery of indigenous mahseers and snow-trouts have completely been wiped off and due to ecological degradation "The winter kill" has become a regular phenomenon. Since the himalayan waterhsheds are characteristically different as compared to the waterbodies in Indian plains, much refined measures are needed for their conservation and further to regenerating fisheries. Present account besides describing anthropogenic and natural causes for habitat degradation, also prioritize various conservation practices in context to Himalayan waters which need to be implemented for restoration of fish habitats. Certain management strategies for the development of coldwater fisheries in Himalayan resources have also been discussed.

C-23

STRATEGY FOR MANAGEMENT OF REVERINE ECOSYSTEMS

Rajshree Srivastava and H.R. Singh

Department of Zoology, University of Allahabad - 211 002

Streams and rivers are more open ecosystems than lentic water bodies . As such, they are more affected by anthropogenic disturbances in the catchment areas . We have studied the effects of such activities on the euthrophication-related parameters *viz* . primary productivity, nitrate-nitrogen, phosphate-phosphorus and transparency and on biological parameters in a large stretch of the Ganga from Kanpur to Allahabad during 1995 to 2000. Standard methods for analyzing the physico-chemical and biological parameters were followed and it was found that anthropogenic activities such as mass bathing during fertivals, burning of dead bodies on the banks, dumping of untreated sewage and other effluents and agricultural practices in nearby fields, not only affect the physico-chemical characteristics and biotic communities such as plankton and fish density etc, but also cause other long range effects and disturb the ecological balance which is one of the desirable uses of the water. Our study suggests that waste load allocation (WLA) principles must be followed for proper water quality management and both point sources and non-point sources of wastes should be regularly monitored and checked. The study also suggests that we must adopt holistic approach for management of rivers. Each river in an extremely rich and diverse ecosystem and any attempt toward management must recognize this diversity . The river system may therefore be managed from the physical, chemical, geological and biological perspectives. Therefore, we suggest that an integrated approach toward river management should be based on a multidimensional model that takes into account all the prespectives mentioned above plus the engineering controls required to reduce the input of wastes. Our model suggests regular monitoring of indicator organisms and all other desirable species.

AUTHORS INDEX