Conference Organization

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Contents

Welcome to Patna!

On behalf of Patna University, India, and the Aquatic Ecosystem Health and Management Society, Canada, we welcome you to the international conference "*The Majestic River Ganga – Health, Integrity & Management*" on the banks of the River Ganga.

The River Ganga is a major and unique river ecosystem for cultural, historical and ecological reasons. It is the largest and holiest river of the Indian sub-continent. The Ganga-Brahmaputra-Meghna river basin harbours approximately 10% of the world's population. Furthermore it has been the cradle of Indian civilization and symbol of purity to millions.

Currently, Ganga is confronted with serious anthropogenic stresses throughout its basin. Organic pollution from domestic sewage, industrial effluents, and toxic chemicals from non-point sources of agriculture and health sectors have seriously deteriorated its ecosystem health. Although the river has been the centre of attention in the day to day life of most of the Indians, it has not received sufficient attention from researchers, environmentalists, managers and politicians concerning the urgency for its remediation and restoration.

In this context, the international Aquatic Ecosystem Health and Management Society and the well known Patna University have jointly organized this international conference to draw attention to the Holy River Ganga, its problems and plight. A total of 64 oral and 21 poster presentations have been arranged into various themes and sessions:

Ecosystem health, water quality and biodiversity
Gangetic Dolphins
Fisheries and wetlands
Comparative river ecology
Management and conservation

The organizing Committee and the AEHMS Secretariat have worked hard to make the conference as productive and enjoyable as possible. An attempt bas been made to avoid concurrent sessions so that integrated information about the river is accessible to all participants. The conference, in addition to the scientific program, includes a culture program, film show and field trip to the river. Overall the Majestic River Ganga conference looks to be an exciting, interesting and productive event, packed full of knowledge and insight for a promising future.

Co-chairs

Mohiuddin Munawar
Research Scientist, Fisheries & Oceans Canada
President, AEHMS,
Burlington, Canada

R.K. Sinha
Professor of Zoology,
Environmental Biology Lab, Patna University
Patna, India

"Ganga has been a symbol of India's age-old culture and civilization, everchanging, everflowing, yet the same Ganga"

- Pandit Jawaharlal Nehru, Prime Minister of India (in his "Will and Testament").

Hosting Organizations

An Introduction to Patna University – Patna, India

Bihar has been a seat of learning since time immemorial. The State had the Universities like Nalanda and Vikramshila that were drawing students from neighboring countries. Patna University established in 1917 is the 7th oldest University of the Indian subcontinent and the first in Bihar. It caters to the growing needs of higher education of Bihar, Orissa and Nepal. The history of this University is closely linked with the history of modern Bihar. It also has a truly national character which transcends the linguistic, cultural and political boundaries.

From the very beginning the University had a number of well-known institutions both professional and non-professional associated with it. It has a full-fledged Law College, Teachers' Training College along with Engineering and Medical Colleges. Furthermore In this age of Information and Communication Technology, the University is not falling behind since it is already providing facilities for Internet, Teleconferencing, online library services etc. Furthermore the has introduced new courses in the areas of emerging importance like Biotechnology, Biochemistry, BCA, MCA, Fashion Designing, Sales Management, Business Management, Rural Management, Functional English, Saral Sanskrit Sambhashan, Journalism and Mass Communication etc. The University also opened new courses to cater to the emerging needs of the Society.

The alumni of this University participated in India's freedom struggle at all stages. When the non-cooperation movement was started by Mahatma Gandhi in 1920, the students of Patna University decided to boycott all Government-run educational institutions. They requested the leaders of the non-cooperation movement in Bihar, Maulana Mazharul Haque, to provide an alternative institution so that they could continue their studies. Bihar Vidyapeeth was, thus, born and the inauguration was performed by Mahatma Gandhi. During the Quit India Movement of August 1942 several students including Baliram Bhagat and L. N. Mishra actively participated.

Right from its inception this University has acted as the torch-bearer of modern scientific and technical education in Bihar, Orissa and Nepal. It is needless to emphasize that the University became the harbinger of modernity, social transformation and economic growth. Right from its establishment the University has been a saga of progress, advancement, and excellence in the field of higher education. The overwhelming number of teachers, lawyers, judges, journalists literateurs, scientists, engineers, doctors, politicians etc., were alumni of the Patna University. The University celebrated its Silver Jubilee in 1944 and its Golden Jubilee (1967), in the year 1970 with the President of India Sri V. V. Giri as the Chief Guest. Many great national leaders and many internationally known leaders and personalities such as Jawaharlal Nehru, Smt. Sarojini Naidu, Govind Ballabh Pant, C. D. Deshmukh, etc have visited the University. Once again the University is joining hands with the International Aquatic Ecosystem & Management Society in organizing this conference for the conservation and management of the majestic River Ganga conference.

An Introduction to the AEHMS - Canada

The **Aquatic Ecosystem Health & Management Society (AEHMS)** was established in 1989 to encourage and promote integrated, eco-systemic and holistic initiatives for the protection and conservation of aquatic resources. The Society has four broad objectives centering on *health*, *management*, the convening/sponsoring of *conferences/symposia* (international/ national/ regional), and *publications* via its primary journal, monograph series and its website (www.aehms.org). The AEHMS was established to undertake the following tasks:

- Envision the promotion and development of the concept of ecosystem health for the protection, conservation, and management of aquatic environments.
- Promote the understanding of aquatic ecosystems structure, performance, function and management from an integrated, multi-disciplinary and sustainable perspective.
- Application of integrated approaches and practices in relation to protection, remediation and restoration of healthy and damaged aquatic ecosystems.
- Disseminate information and organize training opportunities for a better understanding of the concept of aquatic ecosystem health.
- Advocate for the development of new approaches, methods, and technologies for the practice of aquatic ecosystem management.
- The AEHMS encourages international, interdisciplinary, and cross-sectoral communication and collaboration among scientists, universities, governments, industry, and the public sector.
- The Society seeks to establish an international network in order to liaise with the scientific community via AEHMS chapters and working groups in various countries.
- The AEHMS organizes and sponsors conferences, symposia on a global basis on diverse and timely topics of scientific importance. For example, AEHMS meetings have been held in Canada, U.S.A., Germany, France, Russia, Portugal, Mexico, The Netherlands, Sweden, Zimbabwe, Italy, Spain, Brazil, Philippines, Kuwait, Ireland, India, Tanzania, Nepal, Belgium, Malaysia, China and currently in UAE. Future symposia are planned for Hong Kong, Burundi and Vietnam.

The Society is actively involved in primary and peer reviewed publications. It publishes a primary journal: **Aquatic Ecosystem Health and Management-AEHM**: Its international journal is published on a quarterly basis (in collaboration with the well known publisher Taylor and Francis, Philadelphia, USA, www.taylorandfrancis.com). AEHM is devoted to an understanding of the ecosystem performance, function and management from integrated, multi-disciplinary and sustainable perspectives. It publishes peer-reviewed original papers, state of the art reviews and critiques on current issues, invited perspective essays, and special issues (devoted to selected themes, approaches, ecosystems). In addition, the AEHMS also produces a peer reviewed book series under the banner of Ecovison World Monograph Series. It has already published 20 peer reviewed books on diverse and current topics.

"The Majestic River Ganga: Health, Integrity and Management" is the third conference that the AEHMS has organized in the Indian subcontinent. Previously the AEHMS co-sponsored conferences in Nanital (Tropical Aquatic Ecosystems: Health, Management and Conservation) in 1999 and Kathmandu, Nepal (The Great Himalayas: Climate, Health, Ecology, Management and Conservation) in 2004. Both the Nanital and Kathmandu meetings resulted in the publication of special issues of *Aquatic Ecosystem Health and Management*. The global program of conferences and publications of the Society is available on the website www.aehms.org.

The Society welcomes individuals for membership from a variety of disciplines. You are cordially invited to join the AEHMS, which includes 4 quarterly issues of the journal.

General Information & Publication Plans

Badges

You should consider your personal name badge as a valuable entry ticket. Please wear your badge at all times during the conference.

Posters

Posters will be displayed for the first 2 days of the conference, to be viewed during tea and lunch breaks.

Publication Plans

Selected manuscripts originating from the conference will be considered for publication subject to peer review in a special issue of the journal, Aquatic Ecosystem Health and Management. Instructions to authors on the preparation of manuscripts can be found on the AEHMS website: www.aehms.org

Due to the large number of manuscripts expected the AEHMS has set page limit guidelines at 6 printed pages for oral and posters, 8 printed pages for keynotes, including tables and figures (Text: Times New Roman 11 pt, Margins: 2.7 cm (1"), Paper: letter size 21.6x28 cm (8.5x11")). A conference Proceedings on the web (www.aehms.org) and/or printed form is also planned.

The deadline for submission of manuscripts is January 15th, 2006. For more information please contact Jennifer Lorimer, AEHMS Coordinator (lorimerj@dfo-mpo.gc.ca).

Publication Questionnaire

If you are interested in being a part of the conference publication please complete the publication questionnaire at the registration desk and send to Jennifer Lorimer, AEHMS Coordinator at lorimerj@dfo-mpo.gc.ca.

Field trip

A field trip to nearby River Ganga has been organized.

Liability

Neither the conference organization, Patna University, nor the AEHMS can be held responsible for damage, loss or theft during the conference.

Program at a Glance

Monday, November 13th		Tuesday, November 14th			Wednesday, November 15th	
8:30-9:30	Breakfast & Registration	7:30-8:30	Breakfast		7:30-8:30	Breakfast
9:30-10:30	Opening & Inauguration	8:30-10:45	Session 3 Keynote: K.K. Vass	9.00 - 5.00 Work Shop: Dolphin necropsy, histopathology, molecular biology including DNA isolation of dolphin tissues etc.	8:30-11:00	Trip to River Ganga
10:30-11:00	High Tea	10:45-11:00	Break		11:00-11:30	Break
11:00-1:00	Session 1 Keynotes: M. Sengupta & R.C. Trivedi	11:00-1:15	Session 3 cont'd		11:30-1:00	Session 5 Keynote: A. Kishor Kunal
1:00-1:45	Lunch	1:15-2:00	Lunch		1:00-1:45	Lunch
1:45:4:15	Session 1 cont'd Keynote: V. Tare	2:00-4:00	Session 4 Keynote: G. Marmulla		1:45-3:45	Session 5 cont'd
4:15-4:30	Break	4:00-4:15	Break		3:45-4:00	Break
4:30-5:45	Session 2 Keynote: R.K. Sinha	4:15-6:45	Session 4 cont'd Keynote: M. Munawar		4:00-4:30	Summary and Conclusions
6:00-8:00	Cultural Program	6:45-7:45	Film show		4:30-5:30	Valedictory session
8:00-10:00	Dinner	7:45-9:00	Dinner		5:30	Adjourn

Oral Program

Monday, November 13th

8:00-9:30 **Breakfast & Registration**

9:30-10:30 **Opening & Inauguration**

10:30-11:00 **High Tea**

Session 1: Ecosystem health, water quality and biodiversity

11:00-11:30 *KEYNOTE*
Water quality issues, status and river conservation plan in India
SENGUPTA, M. & DALWANI, M.

11:30-12:00 *KEYNOTE*
Water quality management in India
TRIVEDI, R.C.

12:00-12:15 Use of a water quality index to assess the status of the River Ganga in West Bengal
KOLE, R. K., SAHA, T., KOLE, S., MAJUMDAR, D., MANDAL, B. & SENGUPTA, M.

12:15-12:30 Toxic metals in the Ganga River System at Varanasi, India
KUMARI, A., KEDIA, D.K., RANI, N. & SINHA, R.K.

12:30-12:45 Extent of waste metal loading at Ganga estuary via the East Calcutta wetland areas
CHATTERJEE, S., CHATTOPADHYAY, B., CHAKRABORTY, A. & MUKHOPADHYAY, S.K.

12:45-1:00 Survey in the downstream of the Ganga river system to assess the condition of the aquatic environment and biota
NATH, A.K. & BANERJEE S.

1:00-1:45 **Lunch**

1:45-2:15 *KEYNOTE*
Water quality changes in the middle stretch of the River Ganga and suggestions for a paradigm shift in the Ganga Action Plan
TARE, V.

2:15-2:30 Hyporheic biodiversity and ecosystem health of Upper Ganges, Garhwal Himalaya, India
SHARMA, R.C.

2:30-2:45 Status of biodiversity of the River Ganga from Barauni to Farakka and their role in the assessment of health of the ecosystem
ROY, S. P.

2:45-3:00 Zooplankton diversity in the River Ganga in Bihar
SINHA, R. K., SHARMA, G., KEDIA, D. K., SINHA, P. & KHAN, K. M.

3:00-3:15 Marine elements among the benthic macro-invertebrates of the River Ganga in India
SINHA, R. K., NESEMANN, H., SHARMA, G., PRASAD, K. & KEDIA, D. K.

3:15-3:30 Seasonal distribution of macrobenthic forms in response to environmental stress of a selected site of the Hooghly estuary in the River Ganga
BANERJEE, P. & BANERJEE, S.

3:30-3:45 Freshwater benthic macroinvertebrate diversity and impact assessment of sugar mill in Lower Gangetic Plains moist deciduous forests of Nepal
SHARMA, S., SHAH, D.N., TACHAMO, R. D. & NESEMANN, H.

3:45-4:00 Illustrated checklist of large freshwater bivalves of the Ganga river system (Mollusca: Bivalvia: Solecurtidae, Unionidae, Amblemidae)
NESEMANN, H., SHARMA, S., SHARMA, G., SINHA, R.K.

4:00-4:15 Seasonality in population density, secondary production and calcium-to-tissue ratio in freshwater limpet (*Septaria lineata*: Archaeogastropoda: Neritidae) of River Ganga
CHATTERJEE, A., JAIN, M., ROY, U.S. & MUKHOPADHYAY, S.K.

4:15-4:30 **Break**

Session 2: Gangetic dolphins

4:30-5:00 *KEYNOTE*
Current status of Gangetic dolphins in the mainstream of Ganga in Bihar, India
SINHA, R. K., KHAN, K. M., KEDIA, D. K., KHAN, I. A., SINGH, A. K., SINHA, S. K. & SHARMA, G.

5:00-5:15 Freshwater dolphins and ecosystem health of the rivers of NE Himalayas
BORUAH, S. & BISWAS, S.P.

5:15-5:30 Population status of Gangetic dolphin (*Platanista gangetica*) in Brahmaputra River within Assam: Is it declining?
WAKID, A., DAS, S., CHETRY, D. & DAS, C.

5:30-5:45 Observations on some behavioral aspects of the Ganges River Dolphin, Platanista gangetica gangetica
SINHA, R. K., SINHA, S. K., KEDIA, D. K. & SHARMA, G.

6:00-8:00 **Cultural Program**

8:00-10:00 **Dinner**

Tuesday, November 14th

7:30-8:30 **Breakfast**

9.00 - 5.00 Work Shop (concurrent):
Dolphin necropsy, histopathology, molecular biology including DNA isolation of dolphin tissues etc.

Session 3: Fisheries and wetlands

8:30-9:00 *KEYNOTE*
Status and scenario of riverine fisheries in India with reference to Ganges
VASS, K.K.

9:00-9:15 Time scale variations in the fisheries of River Ganga
SETH, R. N. & PANWAR, R. S.

9:15-9:30 A time series assessment of the status of fisheries of River Ganga
VASS, K.K., DAS, M.K., MUKHOPADHYAYA, M.K., KATIHA, P.K., MAJI, S., DEY, S. & SRIVASTAVA, P.K.

9:30-9:45 Age pyramids: indicators of health of exploited fish stocks
NAUTIYAL, P., DHASMANA, P., DWIVEDI, A.C. & RIZVI, A.F.

9:45-10:00 Variations in protein, carbohydrate and lipid content of fish muscles due to aquatic pollutants from River Ganga
VERMA, P., & NATH, A.

10:00-10:15 Trends in potential energy resource and its utilization in the Kanpur – Patna stretch of Ganga
PATHAK, V., TYAGI, R.K. & PANWAR, R.S.

10:15-10:30 Ecology of *Schizothorax plagiostomus* Heckel in the Jhelum river system in Kashmir Himalaya
YOUSUF, A.R., MAHDI, M. D. & BHAT, F. A.

10:30-10:45 Seasonal fish species richness, diversity and aquatic habitat of the selected stretch of River Ganga in U.P.: An ecosystem approach for conservation
SARKAR, U.K., PATHAK, A.K., PAUL, S.K. & LAKRA, W.S.

10:45-11:00 **Break**

11:00-11:15 River conservation requires habitat restoration
GOPAL, B.

11:15-11:30 Impact of anthropogenic stress on rare ornamental fish of head water Ganges of Nepal
SHRESTHA, T.K.

11:30-11:45 Status of Hilsa fishery in the Hooghly estuary – a critical analysis
KARMAKAR, H. C., MISRA, R. N. & VASS, K. K.

11:45-12:00 Ecosystem and fish health assessment in the Hooghly/Ganga river system
DAS, M.K., SAMANTA, S., SAHA, P.K. & MITRA, K.

12:00-12:15 Fisheries status of floodplain wetlands of the Gangetic basin in West Bengal
BHAUMIK, U., PARIA, T. & SAHA, S.

12:15-12:30 Integration of floodplains into management of River Yamuna in Delhi Stretch
TRISAL, C.L. & KUMAR, R.

12:30-12:45 Wetlands water quality – a key factor for sustainable development and growth
LADHAR, S.S. & PARWANA, H.K.

12:45-1:00 Artificial wetlands: an effective tool for preservation of the ecosystem of the River Ganga
DANDIGI, M. N. & SALEEM, A.

1:00-1:15 Conservation of Indian aquatic avifauna verses health and management of the Gangetic ecosystem
YAHYA, H. S. A.

1:15-2:00 **Lunch**

Session 4: Comparative river ecology

2:00-2:30 *KEYNOTE*
Conservation and rehabilitation of rivers for fish and fisheries in the light of the FAO Code of Conduct for Responsible Fisheries (CCRF) and the related Technical Guidelines
MARMULLA, G.

2:30-2:45 Biodiversity of headwater rivers of Nepal and conservation issues
SHRESTHA, T.K.

2:45-3:00 Present status of Ichthyofaunal distribution of Damodar river system –a tributary of River Ganga
SARKAR, L. & BANERJEE, S.

3:00-3:15 Length-weight relationship in coldwater fishes of Himalaya
NAUTIYAL, P., VASHISTA, P. & DHASMANA, P.

3:15-3:30 Longitudinal distribution in the rivers of central India (Vindhyan region): Benthic macroinvertebrate communities
NAUTIYAL, P. & SHIVAM, A.

3:30-3:45 Fishery resources of the Narayani river system, Nepal
JHA, D.K.

3:45-4:00	A glimpse into the fish biodiversity of North-East India KAR, D.
4:00-4:15	**Break**
4:15-4:45	*KEYNOTE* Global threats and impacts of aquatic invasive species to biosecurity: Lessons learnt from the North American Great Lakes MUNAWAR, M., MANDRAK, N.E., MUNAWAR, I.F., FITZPATRICK, M. & NIBLOCK, H.
4:45-5:00	Development impacts on ecosystem in tropical rivers of Asia: Case studies DAS, B.P.
5:00-5:15	Conservation status of aquatic animals in protected and unprotected rivers in India RAO, R.J.
5:15-5:30	Longitudinal distribution in the mountain streams (Mandakini Basin, West Himalaya - India): benthic macroinvertebrate community NAUTIYAL, P. & SEMWAL, V.P.
5:30-5:45	Kuvempu University limnological study of Tungabhadra River near Harihar, Karnataka MANJAPPA, S., SURESH, B., PUTTAIAH, E. T.
5:45-6:00	Status of ecosystem health of six major river systems of Kerala (S.India) and management plans for the conservation of fish germplasm resources KURUP, B.M.
6:00-6:15	Studies on biotic diversity of Macroinvertebrates in central zone of Narmada River SINGH, K., BISWAS, N., BALPURE, S. & SHRIVASTAVA, P.
6:15-6:30	Water quality index of the rivers of North Bihar namely Daha, Sikrahana and Burhi Gandak KUMARI, K., RANJAN, N. & SINHA, R.C.
6:30-6:45	Analysis of environmental impact on first stage project of South –North Water Diversion of China and control measures ZHANG, Y.
6:45-7:45	**Film Show**
7:45-9:00	**Dinner**

Wednesday, November 15th

7:30-8:30 **Breakfast**

8:30-11:00 **Trip to River Ganga**

11:00-11:30 **Break**

Session 5: Management and conservation

11:30-12:00 *KEYNOTE*
Historical, cultural and religious significance of River Ganga (Tentative title)
KISHOR KUNAL, A.

12:00-12:15 Vanishing essence of the mighty River Ganga
CHAUDHARY, U. K., ANKUR, K. & SHUKLA, R.

12:15-12:30 Impact of management and property regimes on fish yield and livelihood of fishers in Ganga river system, India
KATIHA, P.K., VASS, K.K. & SINHA, M.

12:30-12:45 Building local watershed partnerships – A watershed management decision framework
ALAGAPPA, M.A.

12:45-1:00 Assessment of some Sewage treatment techniques in reduction of solid wastes including other pollutants under Gangetic West Bengal
SAHA, T., KAR, D., ALAM, S., MANDAL, S.K., KOLE, R.K. & MANDAL, B.

1:00-1:45 **Lunch**

1:45-2:00 Ecosystem health of shallow water bodies - a modeling study
SAMAL, N. R., SINGH, K. S. P. & MAZUMDAR, A.

2:00-2:15 A holistic approach for management of ecosystem health of River Ganga
SALEEM, A. & DANDIGI, M.N.

2:15-2:30 Management of health of River Ganga – An historical perspective
JHA, V. & VERMA, A. M.

2:30-2:45 Vermi-filtration of sewage with synchronous treatment of sludge by earthworms : A low-cost decentralized system of sewage treatment proposal for River Ganges water shed
SINHA, R. K.

2:45-3:00 Integrated Management of Ganges Flood Plains and Sundarbans Ecosystem
KARIM, M. R. & ASHIQ-UR-RAHMAN, M.

3:00-3:15 Eco-friendly management of Indo-Gangetic wetlands: issues and strategies
SIKKA, A.K. & KAUSHAL, D.K.

3:15-3:30	Potentiality of some sewage treatment plants in improving municipal sewage water quality in Gangetic West Bengal KOLE, S., SARDAR, D., MUKHERJEE, P., KOLE, R.K., SAHA, N. & DALWANI, R.
3:30-3:45	Need for addressing ecological and institutional linkages for sustainable development in the lower Ganga delta RUDRA, K., KUMAR, B. & BANDYOPADHYAY, J.
3:45-4:00	**Break**
4:00-4:30	**Summary and Conclusions**
4:30-5:30	**Valedictory session**
5:30	**Adjurn**

List of Posters

ALAM, S., MUKHERJEE, P., SARDAR, D., KOLE, R.K., BANERJEE, H. & SENGUPTA, M.
Status of pesticide residues occurring in sewage sludge produced by various sewage treatment plants located in some districts of Gangetic West Bengal

ALI KHAN, M.A., ALI KHAN, I. & ASHWANI, K.
Physiological effects of distillery effluent on Majestic river ganga and its restoration through Ferti-irrigation for sustainable development

ANUPAMA & GUSAIN, O.P.
Habitat degradation of Himalayan mahseer in an Upper Ganges tributary

TANUJA & BEDI, S.
Isolation of antibiotic resistant coliforms from River Ganga in between Varanasi and Patna

CHOUDHARRY, S., AHMAD, S., KUMAR, C. & AKHTAR, A.
A study of the diversity of Mycoflora of Ganga River from Danapur to Mokama (Bihar)

GARG, R.K., SAKSENA, D.N. & RAO, R.J.
Monitoring of water quality of Chambal River at Palighat, Rajghat and Baraighat in National Chambal Sanctuary, Madhya Pradesh and its suitability as habitat for aquatic animals including endangered species

GUSAIN, O.P., PRAKASH, M., & RAGHAV, D.
Density, distribution and diversity of benthic macroinvertebrates: a case study of a watershed in the Upper Ganga region (Garhwal Himalaya)

JHA, B.C.
Assessment of algal diversity in the lower reaches of river Ganga including the Bhagirathi

JOSHI, K. D.
Status of fisheries resources in the rivulet Ladhiya, an upland tributary of the Ganga river system

KAR, D., MANDAL, S. K., SUR, P., KOLE, R. K., DAS, D. K. & DALWANI, R.
Assessment of heavy metals pollution occurring in sediments of the river Ganga in West Bengal

SINHA, R. K., PRASAD, K., SHARMA, G., & KEDIA, D. K.
Mercury load in the River Damodar in India

SINHA, R.K., KHAN, K.M., KEDIA, D.K., SINHA, S.K., & SHARMA, G., Avian diversity with special reference to waders in lower middle reaches of the River Ganga, India

SHARMA, S.K., KUMAR, P., CHAUBE, U.C., MISHRA, S.K., & SHARMA, P.
Effect of regulated flow on benthic macroinvertebrates of the River Satluj

KUMAR, R., & SHARMA, K.
A comparative assessment of water quality of River Ganga in Kanpur (U.P) and Patna (Bihar): a brief appraisal

PRAKASH, S. & PANWAR, R.S.
Impact of environmental modifications on the fishery, population and reproductive biology of Gangetic Prawns

PRASAD, K., SINHA, R.K., DALWANI, R., KEDIA, D.K., SINHA, S.K., RUKHAIYAR, S.S., RANI, N., KUMAR, V., SINHA, A.K. & KHAN, F.A.
Water quality in middle-lower reaches of the River Ganga in Bihar, India

RAI, P.K. & TRIPATHI, B.D.
Heavy metal and microbial pollution of the River Ganga: a case study at Varanasi

ROY, S.P., AFSAR AHMAD, M., RAJA RAMANAND, K. & VARDHAN, P.
Food web structure of River Ganga: a tool for detecting ecosystem responses to anthropogenic stress

SHARMA, S., TACHAMO, R. D., SHAH, D.N. & NESEMANN, H.
Assessing the saprobic water quality of Punyamata Khola, Banepa Valley by benthic macroinvertebrates

TAIGOR, S.R. & RAO, R.J.
Threats on aquatic animal biodiversity of Ganges River System due to various activities: in perspective of Chambal River, Madhya Pradesh, India

YOUSUF, A. R., BHAT, F. A., MAHDI, M. D., AHMAD, A. & JAHANGIR, A.
Limnological features of some typical water bodies of Ladakh

Oral Abstracts

Alphabetical by presenting author

ALAGAPPA, M.A., Research Department of Environmental Sciences, Bishop Heber College, Tiruchirapalli – 620017, Tamil Nadu, India. **Building local watershed partnerships – A watershed management decision framework**

River Cauvery watershed is an important demarcation for considering food security and environmental sustainability. The water quality of River Cauvery is considered mildly polluted. The tributaries appear to be more polluted than the main river due to point and non-point sources in Bhavani, Erode, Komarapalayam, Pallipalayam and Tiruchirappalli municipalities. Though the pollution is smaller in the River Cauvery range, it has all the potential of becoming a major problem with rapid industrialization along the river course. This has necessitated the GOI to enforce Pollution Abatement Schemes (PAS) in the above five municipalities. In order to assess and evaluate the success of the above programmes, a preliminary study was conducted. The results reveal that the pollution status is gradually improving, with little fluctuations due to flow and discharge in the main river. The study also indicates that there is a lack of awareness about point and non-point sources of pollution and the establishment of PAS among the public. Further, there is a lack of building partnerships with the stakeholders. This study calls for a watershed management decision framework that would facilitate planners to build partnerships. The role of stakeholders, partnership agreements, their contributions, consensus and team building exercises has been elaborately dealt with in this paper. Hence an approach that encourages community – based involvement would be viable option for a successful watershed management plan.

BANERJEE, P. & BANERJEE, S., Aquaculture Research Unit, Department of Zoology, University of Calcutta, Kolkata 700019, India. paramita_06feb@rediffmail.com. **Seasonal distribution of macrobenthic forms in response to environmental stress of a selected site of the Hooghly estuary in the River Ganga**

Studies of physiochemical parameters and distribution of macrobenthic forms in the River Ganga were undertaken in three polluted areas in the upper stretch of the river including Konnagar, Uttarpara and Bally from October 2003 to November 2005. Soil texture varied from sandy to clay. Organic content of soils varied from 0.43 - 0.57% while pH ranged from 7.6-8.7. It appears that allochthonous materials carried by river varied greatly in both composition and nature, which influenced the variability of organic matter in the estuary. Surface water temperature along the entire stretch ranged from 27°-330° C and was lower than the air temperature (33° – 37° C). Dissolved oxygen values appeared above the critical limit (1.9 mg l^{-1}). The study found 11 species of macrobenthic forms including Polychaeta (*Nephtys polybranchia*), Oligochaeta *(Tubifex tubifex*),Gastropoda (*Thiara lineata, Thiara tuberculata, Thiara scabra, Assiminea fracesiae,Macrochlamys indica, Indoplanorbis exustus, Gangetica miliacea*),Bivalvia (*Novaculina gangetica*) and Crustacea (Scylla serrata). Among these species, *Thiara lineata* and *Tubifex tubifex* were in abundance. The former species appears in greater number at Bally while the later species was prominent at Konnagar. Macrobenthos showing a significant variation in distribution pattern along with the variable physiochemical characters of water and soil. This variation is most apparent at sites under stressed conditions and highlights the use of some macrobenthic species as bioindicators for environmental monitoring.

BHAUMIK, U.[1], PARIA, T.[2] & SAHA, S.[1], [1]Central Inland Fisheries Research Institute, Barrackpore, India. utpal_bhaumik@yahoo.com; [2] Department of Fisheries, Government of West Bengal, India. **Fisheries status of floodplain wetlands of the Gangetic basin in West Bengal**

The floodplains of the Ganga river system in West Bengal constitute an important fishery resources depicting average production of 600 kg ha^{-1}. Threats to the continuing functioning of the Ganga and its floodplains as living systems have reached a critical level, the key factors of which are pollution, competition for water, habitat alteration, siltation, irrational uses of water, introduction of exotic species and irrational exploitation of fishery. Availability of fish in the floodplain wetlands at present indicates carp 28.4%, catfish 23.3%, murrels 18.9%, featherback 3.7% and miscellaneous 25.7% revealing a number of species as threatened categories, against the base year of 1970. It has been estimated that 129 fish species are available presently in the Gangetic basin along with floodplains of this region. During the period 2003-05 a field investigation was carried out with structured schedule for assessment of the status on the locations, area, fish production, fish diversity, threats etc. of floodplain ecosystems of the Gangetic basin in West Bengal. It may not be possible to achieve equitable and sustainable socio-economic development for the people of this region without improving the sustainability of the ecosystem through responsible utilization of water resources by the people.

BORUAH, S.[1] & BISWAS, S.P.[2], [1]Dept. of Zoology, D.H.S.K. College, Dibrugarh 786001 Assam, India. s_boruah@yahoo.com; [2]Dept. of Life Sciences, Dibrugarh University, Assam, India. **Freshwater dolphins and ecosystem health of the rivers of NE Himalayas**

The Brahmaputra and the Barak are the two major rivers systems of NE Himalayas and they cover different climatic zones, landscapes and bio-geographic regions. This has given rise to diverse types of water bodies which make the twin basin a home for over 300 species of aquatic fauna ranging from tiny colorful wetland fishes to gigantic freshwater dolphins. However, a silent havoc is going on unnoticed leading to the gradual disappearance of food fishes and freshwater dolphins. The study analyses the impact of hydrological and anthropogenic factors on the riverine ecosystem taking dolphins as indicator species. For this, hydrobiological data including fishing pressure analysis been carried out. The geological record indicates that the NE Himalayan region, particularly the Brahmaputra basin is very unstable as it is located in a seismic zone constituted by alluvial soil which results in the river transporting the highest sediment load in the world. High rates of siltation (average 3 cm yr^{-1}) not only raise the riverbed and lead to a widening of the river and a decrease in water-cover for mega fauna, but also blocks channel mouths of floodplain lakes, preventing auto-stocking of fish and auto-removal of floating macrophytes during monsoon months. Construction of embankments for flood control has led to the shrinkage of riparian ecotonal zones which provide natural feeding and breeding ground for number of aquatic species. Illegal fishing practices have also worsened the situation. Habitat alteration, siltation, and rampant fishing have caused qualitative and quantitative changes in the faunal diversity. An integrated water resource management strategy incorporating the knowledge of the complex interaction between riparian and aquatic ecosystem and all anthropogenic activities has been emphasized for sustainable utilization of aquatic resources.

CHATTERJEE, S., CHATTOPADHYAY, B., CHAKRABORTY, A. & MUKHOPADHYAY, S.K., Government College of Engineering and Leather Technology, Block-LB, Sector-III, Salt Lake City, Kolkata 700 098, India. chats_75@rediffmail.com, chats.75@gmail.com. **Extent of waste metal loading at Ganga estuary via the East Calcutta wetland areas**

Along a mature delta of River Ganga, on the eastern edge of the city of Kolkata, a vast wetland area is present, the East Calcutta Wetlands comprising over 12,500 ha (after a crunch of 26% in last fifty years). Through its eastern limit flows the River Kultigong, a tributary of Ganga. This wetland receives huge amount of city's composite effluent (nearly 50,000 m^3 d^{-1}), which flows through the Storm Water Flow canal (SWF) into the wetland for nearly 40 km and is finally discharged into Kultigong. These effluents, tainted with metals, carry waste from around 6000 industries including tanneries, electroplating and rubber as well as municipal sewage. It is very important to find out the metal load in water and bottom sediment as this water is being carried away into the River Ganga. For assessing the metal profile we employed Proton Induced X-Ray Emission (PIXE) technique using 3 MeV tandem Pelletron (at Institute of Physics, Bhubaneswar, India). Several elements were detected along with S, K, Ca, Ti, V, Mn, Fe, Ni, Cu, Zn, As, Br, Rb, Sr, Zr and Pb. Gradual decrease in concentration levels (extent of 30.0% to 95.0%) of metals like Ca, Cr, Cu, Mn, Zn and Pb was observed in the bottom sediments along with the overlying water from the source point through the SWF canal up to its site of confluence at Kultigong, indicating a natural biological remediation processes taking place. Any further conversion of this wetland area should be prevented in order to get benefit from this no-cost natural clean-up process.

DANDIGI, M. N. & SALEEM, A., Civil Department, PDA College of Engineering, Gulbarga-585102 India. mndandigi@yahoo.co.in. **Artificial wetlands: an effective tool for preservation of the ecosystem of the River Ganga**

This paper presents a study of an artificial wetland, at Warangal, in the state of Andhra Pradesh, India, used for the treatment of municipal wastewater. Such treatment processes are in great demand because of their satisfactory performance, low maintenance and operating costs and eco-friendliness. A free water surface type of artificial wetland was studied, with dimensions 20.0m X 5.5 m, and a depth 0.4 m. The retention period was 7 days. Wetland vegetation consisted of the emergent macrophyte *Typha latifolia*. Removal efficiencies of 70% for COD, 65% for Nitrate, 99% for pathogens were achieved over a period of one year. The overall effluent quality was found to be acceptable for disposal into water bodies and / or reuse for irrigation. As the climate and typical raw wastewater quality are similar in Gangetic basin, this type of treatment may be the most economical and feasible option for treating municipal and industrial wastewater in order to preserve the natural eco-system of Ganga River.

DAS, B.P., Spatial Planning Analysis and Research Centre (SPARC), 717, Saheed Nagar, Bhubaneswar, 751007, India. bishnupdas@hotmail.com. **Development impacts on ecosystem in tropical rivers of Asia: Case studies**

All tropical or semitropical rivers support rich aquatic biodiversity. Yet developments for hydropower and irrigation by building dams or large diversions have come at the cost of a profoundly altered river. Resultant low or no flows affect riverine health. The perception of development from such a narrow economic interpretation has to be broadened to adequately support fish, wildlife habitat and good in-stream water quality. Due to dams built on the Indus, in India and Pakistan, terminal outflow has been reduced to a mere 20 MAF from 150 MAF devastating the delta. For Mekong, the largest river in Southeast Asia, a significant reduction of 10% in both wet and lean season flows has occurred in the last 30 years causing Great Tonle Sap lake to adversely impact the Vietnam delta. Dams on Amu-Darya and Syr-Darya in Central Asia have reduced terminal flow into the Aral Sea from 60 km^3 (1950) to only 7 km^3 (1995). For River Ganga, control structures have significantly reduced river flows with wetlands drying up leading to declines in fish catch. The impact on the terminal estuary supporting 220km^2 of mangrove by a large dam on River Brahmani, India is presented. A case study of these dams and others with data relating to yield, utilization and need of ecosystem, impact on river health and declining fisheries are presented. A brief presentation is also made on the High Aswan dam that abstracts 90% of flow resulting in silt famine and severe erosion.

DAS, M.K., SAMANTA, S., SAHA, P.K. & MITRA, K., Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, West Bengal, INDIA. mkdas412@rediffmail.com. **Ecosystem and fish health assessment in the Hooghly/Ganga river system**

River Hooghly, the extreme downstream of the Ganga river system, passes through a dense industrial zone and is subjected to various anthropogenic stresses resulting in impairment of the ecosystem and fish health. A 117 km stretch (Nabadwip to Rishra) of the river was assessed for its soil and water quality and fish health. The application of a suite of bioindicators to monitor the ecosystem's health has been evaluated for last four years. Two sites of the stressed zone exhibited relatively high sediment specific conductance (max 0.36 to 0.55 mS cm^{-1}), and organic carbon (up to 0.62%). The water phase at the same stressed sites also exhibited relatively high specific conductance (max 583 to 1062 μS cm^{-1}), COD (8 to116 ppm) and soluble phosphate (max 8.2 ppm) compared to the reference site. Residues of organochlorine pesticides were recorded in fish flesh and water. 4,4′ -DDT was present in water, in concentrations higher than its permissible limits. Active monitoring of fish *Labeo rohita* and *Rita rita* in the disturbed sites did not elicit significant response in the stress sensitive physiological parameters except plasma cortisol. The health assessment index (HAI) of *R. rita* from the stressed site was high (60) with elevated spleno-somatic index and decreased hepato-somatic index compared to the reference site. Index of biotic integrity (IBI) values was significantly lower in the three stressed sites and only three of the studied sites supported fishery in acceptable condition. It is inferred that though the water quality does not reflect significant contamination, yet IBI was impaired at the three sites because of frequent desiltation of the riverbed for brick preparation, and obliteration of the pools which provided optimum habitat for food, shelter and reproduction of the fishes at the impaired sites.

GOPAL, B., School of Environmental Sciences, Jawaharlal Nehru University, New Delhi 110067. rij@nieindia.org. **River conservation requires habitat restoration**

The current state of Indian rivers and the need for their conservation are well known. The Ganga Action Plan, started in 1985 for improving river water quality, has been expanded into a National River Conservation Plan (NRCP) covering all major rivers and their main tributaries. However, the NRCP focuses mainly upon interception, diversion and treatment of domestic sewage of larger urban settlements. Despite these efforts at an enormous cost, no desirable improvement in the water quality has been observed; rather in many reaches of many rivers it has deteriorated. The riverine biodiversity in general, and fisheries in particular have declined greatly.

Although the difficulties in the operation and maintenance of the STPs and the consequent inefficient treatment of wastewaters are widely recognized as major problems, we remain oblivious of the root causes of the problem. We fail to recognise that rivers are NOT mere conduits of the water that runs off from their catchments but they are four-dimensional ecosystems whose ecological integrity depends upon the interplay between their habitat, biota, flow regimes, catchment and floodplains, and water quality. Excessive, often near total, withdrawal of natural flows and intensive channelization by embankments have destroyed riverine habitats, eliminated floodplains and depleted biodiversity, turning the rivers into open sewers and effluent drains. This presentation calls for the urgently needed restoration of habitats, revival of floodplains and ensured environmental flows if the rivers are to be conserved for their ecosystem services and biodiversity. Such restoration efforts require an emphasis on ecosystem approach to river conservation and management, coordination between various stakeholder ministries and departments, and the recognition of the riverine biota as genuine stakeholders and the value of ecosystem services.

JHA, D.K., Department of Aquaculture, IAAS, Rampur Campus, Chitwan, Nepal. dkjha_iaas@yahoo.com. **Fishery resources of the Narayani river system, Nepal**

The Narayani River is one of the largest rivers of Nepal, which is the final collector of seven extremely complex drainage systems of the trans-Himalayas called Sapta-Gandaki, and is one of the major tributaries of the majestic River Ganga. Despite an already rich faunistic diversity reported by various authors, fish stocks in the Narayani River have been undergoing changes. A study was conducted to assess fishery resources of the River Narayani along with its feeder streams in Chitwan district. Eighty-three species of fishes belonging to 9 orders, 23 families and 57 genera were collected from various sections of the river. The presence of fish species have indicated that the resource supports rich and varied indigenous stock of carps, cat fishes, sheat fishes, gars, gobies, snakeheads, feather backs, loaches, eels and puffers, Several kinds of fishes showed the discontinuous distribution among the sampling points. The catch composition has changed towards abundance of species of lesser economic importance. The occurrence and distribution of different kinds of fishes with their updated nomenclature and systemic position according to the resent classification are listed. The fish species of the river show a close affinity with the species reported in the Ganga River of India. The significance of the river for conservation and possible approach for utilization of resources are also discussed.

JHA, V. & VERMA, A. M., Department of Botany, C. M. Science College, Darbhanga – 846004, Bihar, India. Vidyaarunjha@rediffmail.com. **Management of health of River Ganga – An historical perspective**

River Ganga is the life line of India and has nursed Indian civilization since pre-historic times. Ganga water is held sacred on account of a high bacteriophage level in it which helps check the proliferation of microbes. However, population explosion coupled with a consumerist approach to life has encroached upon the sacredness of the river. Cleansing Ganga needs to be made a mass movement. Initiatives launched by some voluntary agencies and religious leaders needs mass support to pressure government. Pilgrimage to the River Ganga is held successful only if one catches a "glimpse" of its beloved progeny in the form of the Gangetic dolphin. For thousands of devotees it is mandatory to plant "sacred basil" and worship the same. There is a need to look into the ancient directives which an average Indian is expected to follow. Scriptural instructions suggest one refrain from defecating in and adjacent to the river. One should not bathe in the river wearing a dress used during defecation. No dirty clothes should be washed in Ganga water. Remains of only a fully burnt corpse should be immersed in its water. Appreciating the ancient Indian wisdom for protection of Ganga water from getting polluted is the need of the hour.

KAR, D., Department of Life Science, Assam (Central) University, Silchar-11, India & Conservation Forum, Silchar-5, India. devashishkar@sify.com. **A glimpse into the fish biodiversity of North-East India**

North-East India is a hotspot of biodiversity. Fish biodiversity for a number of rivers in NE India have been studied. Preliminary assessment revealed the occurrence of 20 and 15 species of fishes in Rivers Lockchao and Khujailok, respectively; 17 species in River Thaobal; 6 species in River Sekmai; 14 species in River Barak; 10 species in River Diyung; 5 species in River Kopili; 8 species in River Dhaleswari; 5 species in River Kynshi; 11 species in River Muhuri, and 14 species in River Subansiri. The River Lockchao revealed the highest fish diversity (Shannon–Weiner Index H=-1.036) while that of River Khujailok was moderate (H=-0.37). The River Diyung was found to have quite rich diversity of fishes (H=-0.943) as did the River Barak (H=-1.22). However, the ichthyodiversity of the River Kynshi (H=-0.503) and Dhaleswari (H=-0.476) were found to be moderate. The micro-habitat in the upstream portion of all these rivers consist of falls, cascades and riffles (occasionally with pools) and the substratum consists mainly of bedrocks, boulders and cobbles. Conversely, the micro-habitat in the downstream portion includes mainly the run and sheet and the substratum mostly consists of fines (silt, sand, clay). The riparian inhabitants in most of these rivers do not generally fish as a profession but rather for personal consumption. Similarities in the fish fauna of the rivers of North-East India with those in the River Ganga could help in tracing the connectivity among different riverine networks. Proper scientific management practices have been suggested in the present communication for protection and conservation of dwindling fish resources.

KARIM, M. R. & ASHIQ-UR-RAHMAN, M., Khulna University, Bangladesh. rk@bttb.net.bd.
Integrated Management of Ganges Flood Plains and Sundarbans Ecosystem

The Ganges floodplain and the Sundarbans ecosystem cover a large area in south-western Bangladesh. In the recent past, major physical interventions in the upstream of the Ganges, like Farakka barrage, and subsequent large scale withdrawals of water without considering its consequence in the downstream ecosystem, are largely responsible for environmental deterioration in this region. The main focus of the study was to find out the problems associated with Ganges flood plains, Sundarbans ecosystem and the consequences for sustainable development of southwest region of Bangladesh. GIS was used for spatial analysis and necessary mapping. The reduction of fresh water through the Ganges because of diversion and unplanned physical interventions and the reduced flow of fresh water through the Ganges has resulted in (a) heavy siltation of the rivers in the Ganges flood plain, (b) increased salinity of soil and water, (c) perennial threats to industrial production due to the lack of fresh water, (d) lowering of the water table which has threatened irrigation and the production potential in the region and (e) top dying of Sundari tree that has threatened future production. The threat to the Sundarbans ecosystem, caused by the shifting of channel directions of the big rivers, has been accelerated due to population growth and the lack of comprehensive management strategies for the natural resource base. This situation is causing a further pressure on the Sundarbans ecosystem. The emergence of an integrated management system is necessary.

KARMAKAR, H. C., MISRA, R. N. & VASS, K. K., Central Inland Fisheries Research Institute, Barrackpore – 700 120, West Bengal, India. cifri@vsnl.com. **Status of Hilsa fishery in the Hooghly estuary – a critical analysis**

Among the anadromous species in tropical estuaries, Hilsa (*Tenualosa ilisha*) has traditionally been a commercially important species in the Hooghly estuary. The species contributes substantially to the estuarine fish production. Peaking in monsoon season, 75 – 90% of the annual yield coincides with the phenomenal rise in reverine flood discharge, desalination of the estuary, declines in ambient temperature and high water turbidity. Annual production of Hilsa is highly variable and long term data analysis indicated bumper production at ten years intervals. The diversion of freshwater through Farakka barrage, upstream of the estuary, has led to a conspicuous drop in salinity and favourably influenced the fishery. Annual production of 1457.1 t recorded during the pre-diversion period (1967-75) increased considerably to 1622.9 t after 15 years (1984-90) and to 10393.3 t over a period of 30 years, following stabilization in the ecology and production of the estuary. Predicted catches for 2005 – 2009 range from 12000 – 14000 t. However, The decline in mean length from 356 mm during 1984-94 to 326 mm in recent years in response to a drop in drift-gill net mesh size to 2 – 2.5 inches, and the wanton killing of juveniles are the alarming factors that negatively impact recruitment potential and may inhibit a sustainable hilsa fishery in the Hooghly estuary.

KATIHA, P.K.[1], VASS, K.K. & SINHA, M.[2], [1]Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, West Bengal, INDIA. pkatiha@yahoo.com; [2]CIFRI, West Bengal INDIA **Impact of management and property regimes on fish yield and livelihood of fishers in Ganga river system, India**

Rivers have multiple uses and are managed as a common property resource (CPR). The Ganga river system is in no way an exception. Most of its stretches are under open access regimes for fishing, although, some have limited access due to transfer of fishing rights to individuals or co-operatives. These property and management regimes have created complexities and conflicts in co-management arrangements which affect the interests of various stakeholders. Implications of these regimes on riverine fisheries and fishers are studied. The study areas are: Kanpur to Farakka under open access; Yamuna Nagar to Panipat under private management (contractor); and Ghagraghat to Faizabad under co-operative management. The analysis concentrated on fisheries assets, fishing status, income and marketing under different regimes. The annual fishing effort was highest for private (293 days) followed by open access (282 days) and co-operative (148 days). The per fisher family annual and daily catch was highest under open access (1432 and 5 kg) and lowest for co-operatives (376.66 and 2.55 kg). The cost structure revealed lowest annual costs for co-operatives, due to lower fishing effort and sharing of fishery requisites. Better marketing practices yielded co-operatives maximum fish price (Rs 34.82). The annual net returns were highest for fishers under open access, but, net returns per kg of fish produced and output – input ratio were the highest for co-operatives (Rs 30.21 and 7.55, respectively). The highest economic efficiency was achieved under the co-operative regime. The privatization of riverine fishing rights has benefited fish traders or contractors at the cost of poor fishers. The study concluded that leasing arrangements in riverine fisheries may be welcomed subject to strict follow up of conservation measures and proper care of equity issues.

SIKKA, A.K. & KAUSHAL, D.K., ICAR-Research Complex for Eastern Region, Walmi Complex, Patna-801505. dkkaushal@rediffmail.com. **Eco-friendly management of Indo-Gangetic wetlands: issues and strategies**

Floodplain wetlands, which cover an area of 2.0 lakh ha, are common features of the Indian landscape, especially along the Ganga and Brahmaputra river basin. These wetlands provide subsistence and livelihoods to thousands of people through fishing, agriculture, water transport and irrigation, besides being rich in biodiversity. However these riverine wetlands are passing through a phase of ecological transition and are loosing ecological integrity because of indiscriminate exploitation. Floodplain wetlands are considered an excellent source of life supporting systems through aquaculture. Twenty-three natural wetlands with an area of 46496 ha exist in Bihar of which Kabar Lake in Begusaria district, Kusheshwarsthan in Darbhanga district and Baraila Lake in the district of Vaishali are most important. These water bodies are highly sensitive, fragile and need eco-friendly management to support biological wealth. Optimum exploitation of floodplains should revolve around the concept of keeping the deeper central portion exclusively for capture fisheries and utilization of margins and pockets for culture fisheries as well as for agriculture. Modern approaches to stocking and rice-fish culture can be adopted for the management of floodplains and oxbows. A good governance system based on a community approach would help in integrated-aquaculture-agriculture operations, ensure equity and minimize conflicts among stakeholders. Moreover, these wetlands are ideally suited for pen fish culture and cage culture. Some of these water bodies should be demarcated as sanctuary for fish germplasm conservation.

KOLE, R. K., SAHA, T., KOLE, S., MAJUMDAR, D., MANDAL, B. & SENGUPTA, M., Department of Agricultural Chemicals, Bidhan Chandra Krishi Viswavidyalaya, Kalyani–741235, Nadia, West Bengal, India. rkkole@rediffmail.com. **Use of a water quality index to assess the status of the River Ganga in West Bengal**

The quality of water in the River Ganga along its 300 km stretch in West Bengal was monitored to evaluate the spatial and temporal variations in terms of various physico-chemical and microbiological parameters including inorganic (heavy metals) and organic (pesticides) pollutants. Water samples were collected once monthly from two sites (middle of the river and a raw discharge point) at four permanent monitoring stations Berhampore, Palta, Dakshineswar and Uluberia from October, 2001 to September 2004. Samples were analysed following the guidelines of APHA (American Public Health Association). All data were subject to statistical analysis (separately for each year) using a factorial ANOVA technique to evaluate the main and interaction effects due to site, location and season. Out of 49 parameters, 15-17 were considered for quality indexing in each year (29 for three years) using Principle Component Analysis. The other 20 parameters were not significantly influencing the water quality. Average scores of the water quality index varied from 0.31 – 0.80 on a scale of 0 – 1 (1 being ideal) with a mean value of 0.52. Index scoring was compared further using the non-parametric Kruskal-Wallis test to evaluate the effects of site, location, season and year of sampling. The uppermost station (Berhampore) exhibited better quality of water in comparison to the downstream stations. Among seasons, water quality was poorest during monsoon. However, there was no significant difference observed in index values due to change in sampling sites at each location. The status of water quality with respect to individual parameters and their cumulative index values over time will be discussed.

KOLE, S.[1], SARDAR, D.[1], MUKHERJEE, P.[1], KOLE, R.K.[1], SAHA, N.[1] & DALWANI, R.[2], [1]Department of Agril. Chemicals and Department of Agril. Chemistry & Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741 235, West Bengal; [2]Ministry of Environment & Forests, New Delhi, India. **Potentiality of some sewage treatment plants in improving municipal sewage water quality in Gangetic West Bengal**

Wastewater treatment is essential before its disposal into open river system. Sewage Treatment Plants (STP) in West Bengal are following the activated sludge process (ASP), trickling filter (TF) and oxidation pond (OP) techniques. The present investigation was aimed to evaluate the efficiency of some STPs in reducing BOD, COD and bacteriological counts of the treated (effluent) sewage water before discharge. Influent (raw) and effluent sewage samples were collected once in every month for three years (2002-05) and analysed following the guidelines of APHA. BOD and COD ranged from 40.0 - 295.0 and 16.0 - 968.0 mg l^{-1} which were reduced to 2.6 - 100.0 and 8.0 - 308.0 mg l^{-1} respectively in effluent. Total Coliform (TC) and Fecal Coliform (FC) bacterial counts in influent samples ranged from 0.004 – 800000 and 0.0005 – 3000 counts/100 ml ($x10^6$) which were reduced to 0.0001 – 8000 and 0.00006 – 90.0 counts/100ml ($x10^6$) respectively in effluent. BOD and COD reduction efficiency varied from 15.0 – 97.64 and 0 – 97.14% with a mean of 71.52 and 53.14% respectively. The removal efficiency for TC and FC ranged from 8.07 – 99.99 and 9.5 – 99.99% with the mean of 83.94 and 83.27% respectively. The OP technique showed the best result by reducing 73.47% BOD, 92.60% TC and 89.93% FC. ASP showed best result for reducing COD (55.11%). No seasonal effect was observed on the efficiency of STPs. Highest removal efficiency of BOD, TC and FC by the OP method and its low operational cost indicate that it is the simplest and the most efficient among the wastewater treatment techniques followed.

RUDRA, K.[2], KUMAR, B.[1] & BANDYOPADHYAY, J.[1], [1]Natural Resources Management Unit., Centre for Science and Environment, 41 Tughlakabad Institutional Area, New Delhi 110062. bidisha@cseindia.org; [2]National Flood-Erosion Management Core Group (NDMA). **Need for addressing ecological and institutional linkages for sustainable development in the lower Ganga delta**

The River Ganga and the vast, intricate mesh of tributaries and distributaries in its lower deltaic region are characterised by some unique hydrological and morphological features, which characteris the region. The expansion of human economic activities and settlements in the flood plains has resulted in changes in dynamics and difficulties in accommodating the combination of natural and anthropogenic changes. In the absence of scientific understanding of the geomorphological processes, these problems are easily labelled 'natural disasters' against which structural measures are recommended. A major engineering intervention in the delta was the construction of a barrage on Ganga at Farakka with the objective of augmenting the flow in the distributary of Bhagirathi-Hugli, upstream of the point where the other distributary, Ganga-Padma enters into Bangladesh from India. As such, coping with the sharing of the lean season flows to meet the heavy demands of water as well as the annual flood flows and associated ecological changes have become more and more complex. It is for an open, scientific understanding of the land and water interactions in the fragile ecosystem of the Gangetic Delta that an attempt is made in this paper to conscientiously analyse the limitations of traditional hydrological engineering approach to the management of Himalayan rivers, like the Ganga. The paper argues that human and ecological security in the delta region could be brought about only by a wider search for the close and interactive linkages between institutional and ecological issues in space and how the knowledge of such linkages can help generate constructive alternatives to meet the challenges of sustainable equitable development and utilization of the Ganga River system.

KUMARI, A.[1], KEDIA, D.K.[2], RANI, N.[2] & SINHA, R.K.[2], [1]Zoology Department, Patna Women's College, Patna University, Patna. rksinha_54@sancharnet.in; [2]Environmental Biology Laboratory, Department of Zoology, Patna University, Patna. **Toxic metals in the Ganga River System at Varanasi, India**

Heavy metals are conservative pollutants being added to the aquatic environment from anthropogenic and natural sources. These elemental pollutants are not degraded and most become bio-magnified and are potent source of toxicity. Heavy metals were studied in the lower – middle stretch of Ganga at Varanasi, India during winter, summer and post-monsoon seasons in 2001. Heavy metals were quantified in different sample matrices viz. water, soil and sediment, suspended solids, and biota (plankton, benthic macro-invertebrates, aquatic and floodplain vegetations, and fish) collected from both upstream and downstream of city of Varanasi. Altogether 252 samples were analyzed for the quantification of cadmium (Cd), chromium (Cr^{+6}), and lead (Pb). Cadmium concentration ranged from NT (not traceable) to 0.142 µg ml^{-1} in water samples while Cr^{+6} and Pb ranged from NT to 1.256 and NT to 2.668 µg ml^{-1} respectively. In suspended solids of river water Cr^{+6} concentration was highest (range; NT – 3962.96 µg gm^{-1}) among all the three metals. Cadmium could not be detected in the suspended solids, while Pb concentration ranged from NT to 327.40 µg gm^{-1} in the same. In river sediment, bank soil, vegetation, and benthic macro-invertebrate samples, concentration of Pb was higher than the other two metals, while in fish samples its concentration was lowest. Highest chromium level (range; NT – 59764.71 µg gm^{-1}) was recorded in plankton samples, while Cd and Pb were highest in fish (196 .60 µg gm^{-1}) and soil (373.80 µg gm^{-1}) respectively. The paper presents an overview of the heavy metal pollution in the Ganga at Varanasi. It details the present concentration profile and their bio-accumulation and magnification.

KUMARI, K., RANJAN, N. & SINHA, R.C., Centre for Environment & Nature Conservation, Dept. of Zoology, Patna University, Patna-800005, India. kanu8@indiatimes.com; rcsinha1@indiatimes.com. **Water quality index of the rivers of North Bihar namely Daha, Sikrahana and Burhi Gandak**

Water quality is a fundamental component of watershed integrity. The aim of the present investigation was to determine the effects of industrial effluents, mainly of sugar and distillery industries and also from non-point sources, on the water quality of the rivers of the North Bihar namely Daha, Sikrahana and Burhi Gandak. Hence, to get a holistic view of the three rivers having appropriate sampling sites, the Water Quality Index (WQI) of the physicochemical parameters as well as the water Quality Value based on bio-monitoring were determined. Besides physicochemical parameters, the determination of Water Quality Value by biomonitoring was also done because the biological community can help determine how healthy or polluted the river is. An advantage of biological sampling (vs. chemical sampling) is that it looks at indicators of conditions which are present in the river over a period of time, rather than just at the moment when a water sample is collected so as to give a total water quality value. Based on the Saprobic and Diversity scores, the water quality of all the three rivers under study was “Moderate”. Since the WQI and the Water Quality value under study was the same it can be concluded that river water has less diversity of aquatic species and frequently increased algal growth which we have found during the present investigation. The decline in diversity species indicates that some input/effluent is having a negative impact on survivability. The ecological significance of these observations is discussed herein.

KURUP, B.M. & MANOJKUMAR, T.G., School of Industrial Fisheries, Cochin University of Science and Technology, Cochin-682 016, India. madhukurup@hotmail.com. **Status of ecosystem health of six major river systems of Kerala (S.India) and management plans for the conservation of fish germplasm resources**

Fish species assemblage, instream habitat, physical and chemical conditions of six major river systems of Kerala: Periyar, Bharathapuzha, Chalakudy, Pamba, Kallada and Kabbini were studied during January 2001 to January 2004 in order to assess the extent of ecosystem imbalance. Principal component analysis was used to find out the habitat parameters which showed maximum variability in each river system. Species assemblage was estimated on the basis of the Shannon-Weiner diversity index, species abundance and index of biotic integrity (IBI) scoring. Multiple linear regression analysis of the critical habitat variables in each river system with Shannon-Weiner diversity explained 68% of the variability in fish species diversity in Periyar river; 70.6% in Bharathapuzha, 90.5% in Chalakudy, 70% in Kabbini, 72.6% in Pamba and 77.8% in Kallada. Multiple linear regression analysis of the critical habitat variables with species abundance explained 59% of the variation in fish species abundance in Periyar River; 24.5% in Bharathapuzha, 67.3% in Chalakudy, 40.9% in Pamba, 25% in Kallada and 29.3% in Kabbini. The results of the present study showed that the ecosystems in Bharathapuzha, Kallada and Kabbini River systems are under great threat. If this ecosystem unbalance continues, these water bodies would become aquadeserts in near future. Among the 6 river systems studied, only Chalakudy River showed signs of a healthy ecosystem. The study also identified the critical habitat parameters in each river system. This study will help policy makers and conservation biologists implement proper management practices for the conservation of fish germplasm resources in order to achieve optimal physical, chemical and biological integrity in the six major river systems of Kerala.

LADHAR, S.S. & PARWANA, H.K., Punjab State Council for Science & Technology, Chandigarh, India. ssladhar@yahoo.com. **Wetlands water quality – a key factor for sustainable development and growth**

Water is the basis of life. Though it occupies 3/4 of the globe, the availability of safe fresh water is a cause of serious concern. Roughly 0.014% of the global water supply occurs in lakes, streams, rivers, etc. broadly termed as wetlands, which have vital role in sustainable development and growth. The quality of water is a key factor that determines the health of these ecosystems. However, water quality in wetlands of Punjab has become seriously degraded during last couple of decades due to pollution of surface water sources. This pollution affects the wetlands' self purification processes and carrying capacities. Water quality in Harike, Kanjli and parts of Ropar wetlands has been degraded to Class 'D'. Their ecological profile is changing towards eutrophic conditions. This, in turn, has led to a new process of weed invasion and changes in species type and diversity. Pollution indicator species have already started dominating in Harike and Kanjli wetlands. Punjab State Council for Science & Technology and Punjab Pollution Control Board has studied the water quality and biodiversity of these wetlands.

MARMULLA, G., Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla, I-00100 Rome, Italy, Gerd.Marmulla@fao.org. **Conservation and rehabilitation of rivers for fish and fisheries in the light of the FAO Code of Conduct for Responsible Fisheries (CCRF) and the related Technical Guidelines**

Fisheries in inland waters have long provided an important source of food for mankind. With the objective to make the use of the resources sustainable and to improve food security and livelihoods, the Food and Agriculture Organization of the United Nations (FAO) has been concerned for decades with inland fishery issues, both through a variety of field-based activities and through its Regular Programme work.

Inland fisheries are in general characterised by the high degree with which they are inter-related with other uses of the aquatic resource. In most areas of the world the principal impacts on inland fisheries do not originate from the fishery itself but from outside the fishery. Consequently most aspects of conservation and sustainability of the resource are under the control of a wide range of interests which are often perceived to be of superior social and financial importance for society. Avoiding or mitigating negative impacts is thus a question of consultation and negotiation with these other stakeholders. Any action for conservation or rehabilitation of the riverine habitat can be based on, and justified by, the provisions of the Code and the FAO Technical Guidelines for Responsible Fisheries.

Far reaching changes to the aquatic environment arising from human activities such as damming for irrigation and hydropower production have led to major modifications of inland water habitats with significant repercussions on fish stocks. The Code of Conduct for Responsible Fisheries and the related relevant Technical Guidelines provide an excellent instrument for the FAO Fisheries Department to promote sustainable development of responsible fisheries by taking into consideration *inter alia* environmental measures in the management of inland waters for fish and fisheries.

MUNAWAR, M.[1], MANDRAK, N.E.[1], MUNAWAR, I.F.[2], FITZPATRICK, M.[1] & NIBLOCK, H.[1], [1]Fisheries & Oceans Canada, 867 Lakeshore Road, Burlington, Ontario, L7R 4A6, Canada. munawarm@dfo-mpo.gc.ca; [2]Plankton Canada, Burlington, Ontario, Canada. **Global threats and impacts of aquatic invasive species to biosecurity: Lessons learnt from the North American Great Lakes**

The North American Great Lakes have suffered from various anthropogenic stresses including eutrophication, toxic contamination and, recently, the rapid expansion of invasive species. In this paper, the North American Great Lakes are presented as a case study to explore the relative impacts of invasive non-indigenous species on the food web and fisheries. For example, the establishment of *Dreissenid* mussels in Lake Ontario in 1990 drastically reduced phytoplankton biomass and affected the plankton size structure resulting in increased water clarity. Assessment of pre and post invasion periods demonstrated drastic biotic alterations at the base of the food web leading to the decline of once healthy fisheries. Non-indigenous fish species have become a significant part of the Lake Ontario food web and several native species have been identified as being at risk. Ongoing changes to all components of the food web due to invasive species represent a serious threat to the integrity of the North American Great Lakes. Numerous examples of trophic disruptions due to such invasions have been reported throughout the world. These non-indigenous invasions pose a serious threat to the ecological security of aquatic resources globally, requiring a concerted effort from scientists, managers and governments to develop strategies for the early detection and control of the expansion of these species.

NATH, A.K. & BANERJEE S., Aquaculture Research Unit, Department of Zoology, University of Calcutta, 35, B.C Road, Kolkata, 19, West Bengal, India. drasimnath@vsnl.net. **Survey in the downstream of the Ganga river system to assess the condition of the aquatic environment and biota**

Physico-chemical and biological characteristics of River Ganga were studied in the area of Serampore (a stretch of about 5 kms), W.B., from January to December 2001, to assess the resource potential of the Ganga. Water samples, plankton, nekton, and benthic fauna were collected from four stations. Faunal composition included different species of fish and a number of planktonic and benthic organisms. Present observations reveal that two stations were more polluted than the other two stations, which is clear by the abundance of two biomarker gastropod species – *Thiara lineata* and *Thiara scabra*. Concentration of heavy metals such as Cu, Pb, Cd and Zn were assessed in water, soil, mollusk and fish to trace the bioaccumulation patterns. Pb and Cd were found in the highest amounts. The fishes found in the study area were mostly hardy and recorded species show a declining trend in contrast to previous surveys. Zooplankton abundance were studied and found in minimum nos. l^{-1}. Physico-chemical parameters of the river water were also studied to present a complete portrait of the Ganga river system.

NAUTIYAL, P.[1], DHASMANA, P. [2], DWIVEDI, A.C.[3] & RIZVI, A.F.[4], [1]Department of Zoology, H N B Garhwal University, Srinagar -246174, India. reader12@rediffmail.com; [2]MKP College, Dehradun, India; [3]University of Allahabad, Allahabad, India; [4]Institute of Applied Sciences, Allahabad, India. **Age pyramids: indicators of health of exploited fish stocks**

Age structure of a population represents the ratio of the various age classes in a population to each other at a given time. The concept that the number of young and middle age classes are more nearly equal in a stabilized population and vary in rapidly growing and senile population resulting in bell, broad based and urn shaped age pyramids, has been used as a tool to know the status of commercially exploited fish stocks. Since population is an **ecological** unit and state refers to **health**, a term '**ecological health**' has been coined to express the status. Broad-based pyramid (rapidly increasing or recovering population) was obtained for *Barilius bendelisis, Cirrhinus mrigala* from the Ganga and Yamuna, both and for *Tor putitora* from Himalaya; urn-shaped (senile population) in *Cirrhinus mrigala, Labeo fimbriatus,* both from the Godavari, *Setipinna phasa* from Ganga and *Cyprinus carpio*, whereas bell-shaped (stable population) patterns were observed in *Barilius vagra* and *Labeo gonius*, *Labeo rohita*., *Labeo calbasu* and *Tor tor*. The latter two tended to be broad-based. The stocks of highly commercial fish were senile or recovering type, indicating poor ecological health. *B. bendelisis* stock has no commercial importance, yet was in poor state due to indiscriminate fishing. Good ecological health of *B. vagra*, which occurs in lower numbers and density than the sympatric *B. bendelisis*, suggests that a good population size is not always an indicator of excellent health and should be used in co-ordination with age pyramids to infer the health of the fish stocks. There is a need to define measures to achieve ideal state in the recovering and senile stocks.

NESEMANN, H.[1], SHARMA, S.[1], SHARMA, G.[2], SINHA, R.K.[3], Aquatic Ecology Centre, Kathmandu University, P.O. Box No. 6250, Dhulikhel, Kavre, Nepal. hnesemann2000@yahoo.co.in; [2]Zoological Survey of India, Patna, India; [3]Patna University, Patna, India. **Illustrated checklist of large freshwater bivalves of the Ganga river system (Mollusca: Bivalvia: Solecurtidae, Unionidae, Amblemidae)**

Twenty-eight taxa of Unionacea and one endemic species of Solecurtidae were reported from the Ganga river system. Their distribution and habitats are described and shell characters are briefly mentioned, supported by 98 figures of forms from different river types. Out of all Unionidae and Amblemidae, 17 taxa (= 60.7%) are endemic to the Ganga river basin and 8 species belong to the more widespread fauna of the oriental region. Furthermore, 8 species are classified as rare and endangered, since only 1 - 3 populations were discovered during extended fieldwork. The taxonomic position of 11 fossil species from the Miocene-Pliocene of Western-Central Nepal is discussed. The use of all available living taxa for biological water quality assessment is proposed assigning indicator value based on the existing biotic score system.

PATHAK, V., TYAGI, R.K. & PANWAR, R.S., Riverine Division, Central Inland Fisheries Research Institute, 24 Panna Lal Road, Allahabad (U.P.), 211 002, India. **Trends in potential energy resource and its utilization in the Kanpur – Patna stretch of Ganga**

During the 1960s, in the Kanpur - Patna stretch of Ganga, the rate of energy transformation by producers was quite high with favorable water quality. The river had high potential energy (155,600 to 277,200 K cal ha^{-1}) and it was properly utilized as evidenced by fish catch (Kanpur-93.6 t; Allahabad-179.73 t; Patna-63.73 t). By 1988, however, due to heavy discharge of effluents the potential energy dropped to 40,800 and 82,560 K cal ha^{-1} at Kanpur and Varanasi. The water quality and potential energy did not show any change at Allahabad and Patna, but fisheries there also followed a declining pattern. In spite of significant improvements in water quality and potential energy due to the regulation and diversion of discharged effluents, the fishery has continued to decline. Hydrological modifications such as reduced water volume, heavy siltation and frequent changes in its course, have badly affected the breeding and recruitment of economically important species. From 1985-2000, the silt load at Allahabad and Varanasi increased 20-35 times and fish production tumbled. Along with quantitative declines, the fishery has shown a drastic change in its qualitative composition and pattern of energy utilization. The potential energy which was mainly utilized by fishes at lower trophic level during the 1960s (Kanpur-53.5%, Allahabad-40.0%, Patna-31.5%) is now being utilized by smaller species (entire stretch: 65-75%) resulting in a great loss of available potential energy.

RAO, R.J., School of Studies in Zoology, Jiwaji University, Gwalior, M.P., 474 011, India. soszool@rediffmail.com. **Conservation status of aquatic animals in protected and unprotected rivers in India**

Species diversity among different rivers of the Ganges river system is similar. The major vertebrate species in these rivers include two mammals (dolphin & otter), more than 100 wetland birds, two reptiles (*Platanista gangetica* and *Lutra* perspicillata), more than 12 freshwater turtles and a large number of fishes. Due to human activities like water development, pollution, commercial exploitation etc., large numbers of aquatic species have became endangered. For biodiversity conservation, the majority of the rivers are at least partially protected. In this paper a comparative account on the species diversity, conservation efforts and management status in the Chambal River and Ganga River is presented. Populations of higher vertebrates are under constant threat in the Ganga due to heavy human activities like fishing, poaching, and habitat destruction. Aquatic life in some stretches of the Ganga is protected by religious people on the river ghats. However, the aquatic fauna in the Chambal River is formally protected by the National Chamabal Sanctuary. Regular monitoring of different species turtles and crocodiles in the Chambal revealed that populations are in good number compared to populations in the Ganga. Similarly, dolphins in the Chambal are increasing due to protection in the Sanctuary, while these animals are heavily exploited in the Ganga. Otters are rarely seen in the Ganga but are in good numbers in the Chambal. Currently, there are no protected areas in the Ganga between Rishikesh and Kanpur. If the National Chambal Sanctuary is taken as an example for protecting aquatic animals, then one or two sanctuaries could be created in the upper stretch of the Ganga.

ROY, S. P., Department of Zoology, T. M. Bhagalpur University, Bhagalpur-812 007, India. soszool@rediffmail.com. **Status of biodiversity of the River Ganga from Barauni to Farakka and their role in the assessment of health of the ecosystem**

The study of the Ganga ecosystem from Barauni to Farakka indicates gradual decline in diversity, abundance, population size and distribution of biota due to habitat alteration and fragmentation by development activities, indiscriminate fishing, pollution, and introduction of exotic species. Many of the once abundant species have declined considerably. Other factors affecting biodiversity are massive deforestation, over-grazing, siltation and eutrophication; which pose a great threat to the river basin as a whole. The present paper deals with aquatic biodiversity (annelids, mollusks, insects, fishes, reptiles, birds, and mammals) of the River Ganga and their relative abundance. The standing crop of macro-invertebrates (annelids, mollusks and insects) was worked out and maximum and minimum overshoots of the population was observed in the months of April and September. The Biotic Index of the Ganga ecosystem, analyzing the community structure of three aquatic insect orders (Odonata, Diptera and Ephemeroptera), was found to be less than 1.75, indicating excellent conditions. The species diversity (H) of mollusks, insects and birds was also analyzed and showed little fluctuation. However, the conservation and management of a life supporting system is a challenge in the Ganga.

CHATTERJEE, A.[1], JAIN, M.[2], ROY, U.S.[3] & MUKHOPADHYAY, S.K.[4], [1]Directorate of Forest, Government of West Bengal, India; [2]Indian Institute of Science, Bangalore, India; [3]Post Graduate Dept. of Zoology, Maulana Azad College, Kolkata-700 013, India. [4]Durgapur Government College, Durgapur, India. msubhro@yahoo.com. **Seasonality in population density, secondary production and calcium-to-tissue ratio in freshwater limpet (*Septaria lineata*: Archaeogastropoda: Neritidae) of River Ganga**

Once abundant in the higher reaches of Ganga, the fresh water limpet (*Septaria lineata)* has become rare. In recent years the limpet been located in a few isolated patches in Hooghly district of West Bengal. From the standpoint of biodiversity conservation, the ecological information on this rare limpet is urgently needed. The distribution, secondary production and Ca:tissue ratios, in relation to limnochemical factors were studied during two successive years. Total hardness, chloride, pH and phosphate were found to be significant in the multiple correlations to influence the abundance of the limpet population. Annual production for the two years was 10.3 g m^{-2} and 9.5 g m^{-2} respectively. Annual turn over ratio (P/B) was calculated to be 2.06 and 1.67 while annual turn over time was 177 days and 219 days respectively. The ratio of whole animal calcium content to tissue dry weight (Ca:tissue) changed with age and size class, but these changes were largely restricted to early growth and did not significantly affect individuals over a particular size (shell height 0.40 – 0.49 cm). Total hardness and chloride were the most important limnochemical factors that seemed to influence the shell:tissue ratio.

SAHA, T., KAR, D., ALAM, S., MANDAL, S.K., KOLE, R.K. & MANDAL, B., Water Quality Monitoring Laboratory, Department of Agricultural Chemicals and Department of Agricultural Chemistry & Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741 235, West Bengal, India. **Assessment of some Sewage treatment techniques in reduction of solid wastes including other pollutants under Gangetic West Bengal**

Sewage treatment plants (STP) in West Bengal are operated based on three techniques, namely Activated Sludge Process, Trickling Filter and Oxidation Pond. The raw (influent) and treated (effluent) sewage water samples were collected from such STPs on a monthly basis for three consecutive years (2002 – 2005) and analyzed following the guidelines of APHA to assess the efficiency of the STPs and also to evaluate the effect of treatment technologies and season on the efficiency of the plants. About 60% and 0.2% of the treated sewage water samples exceeded the safety limits in terms of TDS and NO_3-N for irrigation. The average efficiency of different STPs to reduce the TSS and TDS from the sewage water varied from 9.64 - 94.74 and 1.04 - 80.00%. The reduction efficiency for NO_3 – N, NH_4^+ - N and PO_4 ranged from 0.00 – 98.66, 0.75 – 99.90 and 31.00 – 97.76%. The Oxidation Pond technique showed the best result by unloading 68.62% TSS, 28.09% TDS, 50.14% NO_3 - N, 60.70% NH_4 – N and 52.16% PO_4. Among the mechanical processes, the Activated Sludge Process showed a better result for removing PO_4 whereas the Trickling Filter worked best for other inorganic pollutants. There was no significant seasonal effect observed on the efficiency of STPs.

SALEEM, A. & DANDIGI, M.N., Civil Department, PDA College of Engineering, Gulbarga-585101, India. as_ismail@qp.com.qa. **A holistic approach for management of ecosystem health of River Ganga**

River Ganga is a lifeline of Indian culture and civilization. Over the ages, Ganga has been a dependable source of water for domestic use, irrigation and other needs, apart from serving as a symbol of faith and devotion. In the recent years, devotees of Ganga have increased manifold. Unfortunately, the quality of water has not been preserved and protected by its many users including individuals, farmers, pilgrims, and industrialists. Regulations have come-up for controlling industrial pollution but attention has not been given to the impact of pollution from other sources. This paper describes the status of Ganga water pollution from non specific and non conventional sources such as the huge number of pilgrims and their offerings into river. The religious value of Ganga needs to be captured in formulating an effective awareness and educational programme. Similar attempts have been made successfully in other parts of the world, wherein religious and cultural values are clubbed with scientific solutions to gain effective implementation. There is a need to develop public awareness and involvement based programmes for preserving water quality. Due to the dense population in the Ganga basin and the enormous number of pilgrims these programmes cannot be ignored.

SAMAL, N. R., SINGH, K. S. P. & MAZUMDAR, A., Department of Civil Engineering, National Institute of Technology Patna, Patna – 800 005, Bihar, India. nihar_samal@yahoo.co.in.
Ecosystem health of shallow water bodies - a modeling study

In the frame work of the present study, the 1D numerical model of the hydrodynamic and thermal structure in the freshwater environment of an artificial shallow lake has been designed and developed as a basis for an ecological water quality model, which is driven by the meteorological forcings. It allows the quantification of the vertical mixing processes that govern not only the thermal structure but also the nutrient exchanges and more generally the distribution of dissolved and particulate matter between different layers of the lake/waterbody. The vertical temperature profiles are calculated by solving the coupled partial differential equations for the temperature (heat energy balance equation), one-dimensional momentum equation and a second order closure scheme for the small-scale turbulence effects, i.e. turbulent kinetic energy and turbulent dissipation rates numerically using an implicit time integration method. The effect of advection due to the inflow and outflow in the present case is not taken into consideration as the shallow waterbodies are assumed to behave as a closed lake. The oxygen level at different layers in these waterbodies is also measured to reflect the hypolimnetic oxygen depletion due to the thermal stratification in the aquatic environment. The changes in the stratification regime in the waterbdies play the dominant role in predicting the water quality and the health of the ecosystem.

SARKAR, L. & BANERJEE, S., 06, Durgapur Colony, Newalipur, Kolkata-700053. ls1969@rediffmail.com. **Present status of Ichthyofaunal distribution of Damodar river system –a tributary of River Ganga**

The River Damodar is one of the prominent tributaries of the River Ganga. It originates from the Khammarpath hills of Palamau and is 541km long. On its way it travels through the dense jungle of Palamau, the industrial belt of Bihar and West Bengal. The river flows through the mineral rich areas,and is home to about 37.2% coal, 35% bauxite, and 43% mica industries of India. Moreover, the river is the main source of water for these industries that produce 310 million tons of coal, 80 million tons of steel and 2000 MW of thermal and hydel power. The river valley is a major wealth-bearing valley, which is affected by the changing land use pattern, physical and ecological stress, continuous dumping of solid rejects, and silt load, and large amounts of industrial effluents. A total number of 79 species belonging to 19 families and 51 genera from this river system have been recognized after a thorough investigation and random collection of fish species through the entire stretch. This number of fish species is different from the previous records. A detailed analysis was made on different hydrological parameters to correlate the distribution pattern of the Icthyofauna in the Damodar river system – an important tributary of the River Ganga. This study is focussed on highlighting the need for immediate conservation.

SARKAR, U.K., PATHAK, A.K., PAUL, S.K. & LAKRA, W.S., National Bureau of Fish Genetic Resources, Canal Ring Road, Dilkusha, Lucknow- 226002, India. usarkar1@rediffmail.com, uksarkar@nbfgr.res.net.in. **Seasonal fish species richness, diversity and aquatic habitat of the selected stretch of River Ganga in U.P.: An ecosystem approach for conservation**

In the present communication fish species richness and diversity of the selected areas of River Ganga in Uttar Pradesh, including a portion of protected areas, were studied during 2004 – 2006 in premonsoon, monsoon and winter seasons. A total of sixty-two species from 42 genera and 22 families were recorded from the River Ganga. Fish species diversity in different sites outside the protected areas was represented by a minimum of 26 to maximum of 42 species. However, species richness in the protected area ranged from 32 to 50 species. The family Cyprinidae was the most dominantly represented group followed by the catfish family Bagridae, Sisoridae and Schilbeidae. Presence of species of high conservation importance like clown knifefish *Chitala chitala*, dwarf goonch *Bagarius bagarius*, giant river catfish *Pangasius pangasius* and IUCN Red listed one-stripe spinyeel *Macrognathus aral* was rare throughout the study area. Among exotics common carp *Cyprinus carpio* was recorded during premonsoon and winter. Shoreline larval sampling carried out during postmonsoon season indicated assemblage of fish species of small, medium and few large- sized species that do not migrate or perform short migration for spawning. Data obtained using Fish Finder (200 KHz) on depth utilization pattern of fish in a transect area of 100 m^3 within the study area of River Ganga indicated the depth range of 6.3 to 7.5 m as most the preferred habitat. Based on the primary data, a set of habitat classes used by groups of fish species classified as conservation and management priorities were developed, threats to fish diversity of the study area were identified and conservation measures have been suggested.

NAUTIYAL, P. & SEMWAL, V.P., Department of Zoology, H. N. B. Garhwal University, Srinagar Garhwal Uttaranchal-246174, India. semwalvp@rediffmail.com. **Longitudinal distribution in the mountain streams (Mandakini Basin, West Himalaya - India): benthic macroinvertebrate community**

Distribution patterns of benthic macroinvertebrate community were observed in mountain streams with respect to sub-basin, forest type, altitude and longitudinally at the basin scale. The Mandakini basin was studied close to snow line. Nine stations were selected on seven streams draining four sub-basins; the Kakra having Conifer Oak- Rhododendron Forest (CORF) and Mixed Forest (MF), Byung with Oak-Pine Forest (OPF) and Swar comprising Banjh-Oak Forest (BOF) and Pine Forest (PF). 900 samples (5 quadrates of 1 ft^2 per site x 9 sites x 20 months) were obtained from May 1999 to December 2000. The density was higher in the Kakra and Swar compared with the Rawan and Byung. The mean density of benthic macroinvertebrate was high during winter (peak January) and low during monsoon (July and August). Trichoptera dominated the Kakra (51%), Byung (45%) and Rawan (40%) while Ephemeroptera the Swar sub-basin. Altitudinally, the Ephemeroptera and Trichoptera occurred in unequal proportions (20-23%, 31-51%) at higher elevation (880-2440 m) in the Kakra compared with balanced share (35-38%, 32-33%) at lower elevation (733-1400 m) in the Swar which was reflected in the forest type and consequently the organic load, thereby influencing the taxonomic composition of the community. Longitudinally, the Ephemeroptera increased with the downward flow the magnitude of which was high in the Rawan (23-34%) followed by Kakra (20-33%) and Swar (35-38%). The forest types and the sub-basins were scraper dominated; Trichopteran in CORF, OPF and MF while Ephemeropteran in BOF and PF, the 'ecological equivalents' within the Mandakini basin. The functional aspect of the Continuum concept did not fit in these streams, due to absence of the shredders. The biome dependency hypothesis also did not fit, as 2 stations in similar forest type (MF) had identical community, but not in the OPF in the Rawan and Byung sub-basins.

SENGUPTA, M.[1] & DALWANI, M.[2], [1]Adviser, National River Conservation Directorate, Ministry of Environment and Forests, Government of India, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi-110003, India. msen2k@lycos.com; [2]Director, National River Conservation Directorate, Ministry of Environment and Forests, Government of India. **Water quality issues, status and river conservation plan in India**

Availability of water in India is highly uneven both in space and time. Of the annual precipitation of 4,000 billion cubic meters (BCM), only 1,869 BCM of water is available from surface and replenishable groundwater sources. There are 14 major river basins occupying 83% of the total drainage basins, contributing about 80% of the total surface flow and serving 80% of the country's population. Due to topographical and other constraints, only 60% of available water can be put to beneficial use. However, the present water use scenario at various sectors shows a major swing in favour of agricultural sectors, followed by domestic and then other sectors. The wastewater generation scenario shows that Indian Class-I cities (423) and Class-II towns (499) generate about 26,000 million litres per day (MLD) of wastewater of which only 7,000 MLD receives treatment. About 57,000 polluting industries produce 13,500 MLD waste water. Only 8,000 MLD from large and medium industries is treated. The rest of the untreated wastewater either finds its way into surface water or to ground water, causing organic and faecal contamination. In this paper efforts have been made to articulate the status and highlight issues related to river water quality in the country. India has launched a National River Conservation Plan covering 34 stretches of polluted rivers in 164 towns in 22 States. A case study based on implementation of the Conservation Plan in River Ganga, one of the largest rivers in the world, has been discussed.

SETH, R. N. & PANWAR, R. S., Riverine Division, Central Inland Fisheries, Research Institute, 24, Panna Lal Road, Allahabad-211 002, Uttar Pradesh, INDIA. rnseth_cifri@yahoo.co.in. **Time scale variations in the fisheries of River Ganga**

Observations on population dynamics of commercially important fishes of River Ganga in and around Allahabad revealed gradual time scale changes in the population structure of many valuable groups of fishes with a steady decline in their total catch. In the sixties, Indian Major Carp fishes (I.M.C.) contributed over 40% to the total catch, with *Cirrihinus mrigala* particularly dominating. During the nineties, the percentage share of the less economically miscellaneous fishes reached above 54%, while carps dwindled to 12%. Interestingly, during the sixties when *C. mrigala* dominated the catch with about 33.5% contribution, *L. calbasu* contributed about 4.5%. By 1985, it started emerging as a major component of major carp fisheries with an enhanced contribution of about 14.6%. This did not last long as catfish populations increased. At present, the contribution of I.M.C. has come down below 10% and contribution of miscellaneous smaller species has increased to about 70%. During the pre-Farakka period (1955-72), the annual catch of *Hilsa ilisha* ranged between 7.87 to 40.16 t, but now it has almost disappeared. The spawn productive potential of the river has also declined. Availability of I.M.C spawn from the river is poor, causing deleterious effects on natural recruitment, essential for survival of major carp stocks. The data on population dynamics of such important fishes and on spawn production potential of the river signify detrimental changes in the fish industry of River Ganga. Habitat variables along with other attributes are discussed in hopes of moving towards conservation of rheophilic fish stock.

SHARMA, S., SHAH, D.N., TACHAMO, R. D. & NESEMANN, H., Aquatic Ecology Centre, Kathmandu University, P.O. Box No. 6250, Dhulikhel, Kavre, Nepal. shahdeepnarayan@yahoo.com. **Freshwater benthic macroinvertebrate diversity and impact assessment of sugar mill in Lower Gangetic Plains moist deciduous forests of Nepal**

Increasing human and livestock population, agricultural intensification and industrilization has caused degradation of river quality in Lower Gangetic Plains moist deciduous forests of Nepal. The present research is focused on the effect of effluents form a sugar mill to the river water and aquatic ecosystem health using macroinvertebrate fauna as biological indicators. Effects to the macroinvertebrate fauna were investigated in terms of the changes in faunal diversity and community composition, abundance, physical and chemical analysis of water. Altogether two rivers and one tributary with seven sites were studied in which two sites were taken as reference sites, three as disturbed sites and two as recovery sites. A surber sampler of 0.1 m^2 area and net size 25×25 cm^2 of 500 micrometer mesh size was used. For each site 20 replicates samples were taken. Qualitative sampling was done by hand net of 500 micrometer mesh size and by handpicking the animals from different substratum. A field protocol was used to collect field information and data while sampling in each site. The proposed scores for the Ganga River System (GRS BIOS) are applied for water quality assessment. MHS sampling recorded 33 taxa from the study sites. These taxa included 2 Ephemeroptera, 4 Odonata, 3 Heteroptera, 2 Coleoptera, 5 Diptera, 1 Mysidacea, 1 Ostracoda, 3 Decapoda, 3 Oligocheata, 1 Nematoda and 8 Mollusca.

SINHA, R. K.[1], NESEMANN, H.[2], SHARMA, G.[3], PRASAD, K.[4] & KEDIA, D. K.[1], [1]Environmental Biology Laboratory, Department of Zoology, Patna University, Patna; [2]Aquatic Ecology Centre, Dept. of Biology & Environmental Sciences, Kathmandu University, Dhulikhel, Nepal; [3]Zoological Survey of India, Gangetic Plains Regional Station, Patna. gopal_dolphinboy@rediffmail.com; [4]Department of Geology, Patna University, Patna. **Marine elements among the benthic macro-invertebrates of the River Ganga in India**

The River Ganga formed in the middle part of the Tertiary epoch. At the beginning of the tertiary epoch the territory, which is now Penninsular India, was separated from the rest of Asia by a broad strait, in which conditions were completely marine. With the elevation of the Himalayas the channels become narrower, but probably were not completed obliterated. The streams that flowed down the southern slope of the new mountain range must have brought with them much alluvium, the accumulation of which at its base would tend to fill the channel. It is possible that there might have been an existence of great lagoons, the inter relations of which were constantly changing, while their bed is now completely buried beneath the alluvial deposits of more recent rivers. Such a history would have given ample opportunities for the migrations of the fauna. Besides migration, biochemical and physiological adaptations of the organisms in these lagoons would have possibly resulted in their survival in the newfound fresh water environment. This might have resulted in occurrence of diverse fossils of the marine organisms in Himalayan deposits and survival/adaptation of many of the marine fauna in the Ganga and its tributaries. Some of the marine species might have migrated or been transported by river traffic inside the freshwater zone of the river in recent times. Annandale gave an account of marine elements in the Ganges 84 years ago. We conducted intensive and extensive surveys of benthic macroinvertebrates in the main stem of the Ganga in Bihar and recorded 2 species of polychaetes, 1 species of Hirudinea, 3 species of Gastropoda, 3 species of Pelecypoda and 2 crustacean species. During the study, 11 species of 7 families of benthic macro–invertebrates of marine origin were recorded in the Ganga.

SHARMA, R.C., Department of Environmental Sciences, H. N. B. Garhwal University, Post Box -67, Srinagar-Garhwal 246174, Uttaranchal, India. drrameshcsharma@yahoo.com. **Hyporheic biodiversity and ecosystem health of Upper Ganges, Garhwal Himalaya, India**

Biodiversity has been recently recognized as one of the most potential and essential characteristics of life for proper functioning of a fluvial ecosystem and a means of coping with natural and anthropogenic environmental changes. In case of hyporheic habitats of Upper Ganges, no information on its biodiversity is available so far. Thus, the objective of the present contribution is to present data on environmental variables of hyporheic habitats, inventorying and monitoring of biodiversity, factors influencing hyporheic biodiversity and its conservation. Standard methodology outlined in Wetzel and Likens (1991) and APHA (1998) was followed for analyzing physico-chemical environmental variables. Siphoning method of Sterba (1990) was employed for sampling from hyporheic zone. Data on environmental variables revealed that the hyporheic temperature, conductivity, total dissolved solids, free carbon dioxide, phosphates and BOD increased with the increase in depths (15, 30 and 50 cm). However, the turbidity, pH, dissolved oxygen, alkalinity and nitrates decreased with increasing depths. The hyporheic biodiversity of upper Ganges is contributed to by microphytobenhtos and microzoobenthos. These hyporheic organisms are instrumental in improving the water quality of the river through the process of filtration, sedimentation, deposition and decomposition. Extraction of building materials (sand, gravel, pebbles, etc.) from the river bank deforestation, sewage mixing with river water, agricultural practices and non point pollution in the catchment area are some of the major factors identified detrimental for hyporheic biodiversity. Therefore, some *ex-situ* and *in-situ* measures have been suggested for the protection of hyporheic biodiversity, which is essential for the amelioration of the health of the ecosystem of upper Ganges.

NAUTIYAL, P. & SHIVAM, A., H N B Garhwal University, Srinagar, Garhawal Uttaanchal, and University of Allahabad, Allahabad , U. P., India. shivam_a2000@yahoo.co.in. **Longitudinal distribution in the rivers of central India (Vindhyan region): Benthic macroinvertebrate communities**

Contrary to their physical and chemical characteristics, the benthic communities respond even to slightest disturbances caused by allochthonous inputs generated by natural and anthropogenic sources. The Rivers Ken, Betwa, and Tons draining the northern slopes of Vindhyan hill in Central India, discharge into the Ganga and Yamuna and are impacted by hydropower generation, industries and agriculture. In view of these facts and the Ken-Betwa link, the benthic macroinvertebrate communities were examined to determine whether these disturbances were reflected in their composition. The macroinvertebrates were sampled intensively (20 quadrates, 1 ft^2) during December 2003 to April 2004 from 5, 4 and 3 stations on the Tons, Ken and Paisuni, respectively, located between 23°59' to 25°46' N latitude, 82°04' to 80°52' E longitude and 500 to 83 m altitude. Samples were obtained by lifting of stones and sieving of the substratum (0.05mm mesh size). Counts were performed to compute percentage composition and density (indiv. m^{-2}). The median density (indiv.m^{-2}) was high in the Paisuni (649.55), compared with Ken (310.7) and Tons (255.8) and differed significantly (Kruskal – Wallis test ($t_{0.05(11)}$ =19.65) despite same agroclimatic conditions. Longitudinal changes in density and taxonomic composition of the community were not consistent among the rivers. The amount of insects was high in the Paisuni and Ken, compared with molluscs in the Tons. The mouth zone of Ken (K4) and Tons (T5) were similar in composition as they differed radically from upstream stations, with a higher share of the molluscs and annelids, while insects became relatively lower. The continuum of community seems to be intact in the Paisuni and disrupted varyingly in the Ken (abrupt decrease in insect and increase in molluscs and annelids) and Tons (erratic increase and decrease of these major groups).

SHRESTHA, T.K., Central Department of Zoology, Tribhuvan University, G.P.O. Box 6133, Kathmandu, Nepal. drtks@ccsl.com.np. **Biodiversity of headwater rivers of Nepal and conservation issues**

The Himalayan kingdom of Nepal has a network of mighty rivers and tributaries and several criss-crossing channels, offering immense scope for expanding fisheries in this country. Well over 200 species of fishes live and breed in Nepal. Habitat alterations continue to have major impart on the distribution, abundance of fishes in large rivers of Nepal Himalayas. The fishes of major rivers and feeder streams are perhaps the least studied and poorest known natural resources. In Himalayan large rivers (Gandaki, Koshi, Karnali and Mahakali) where people live, fish and settle, the natural fish habitat has been modified by man for centuries. Power dams have drastically altered fish habitat and communities and blocked seasonal movement of pristine migratory fishes such as *Tor tor, Schizothorax richardsoni, Anguilla bengalensis, Bagarius bagarius* and *Clupisoma garua* etc. Many upriver habitats disturbed by dams are less congenial for rheophilic fishes such as *Psilorhynchus pseudecheneis, Balitora brucei, Garra gotyla, Glyptothorax pectinopterus* etc. Besides fish, many aquatic birds, mammals and reptiles are threatened to extinction such as, Greater adjutant stork (*Leptotilos dubius*), Sarus crane (*Grus antigone*), Gharial (*Gavialis gangeticus*), turtle (*Lissemys punctata, Aspideretes gangeticus*), River otter (*Lutra perspicillata*), and Gangetic dolphin (*Platanista gangetica).* The problem of conservation of biologically diverse food and game fish and their top predators living in large rivers are carefully reviewed. Establishment of fish parks, aquaria and river parks, wetland bird sanctuaries, and reservoir edge fresh water parks in tail water of dams, are suggested as a means to heighten public awareness about economically valuable riverine animals and preserve them for the future. Specific problems linked with health of Ganges river system and conservation of biodiversity in the Gandaki river systems of Nepal are discussed and data gaps identified. Recommendations are given for conservation and management action.

SHRESTHA, T.K., Central Department of Zoology, Tribhuvan University, G.P.O. Box 6133, Kathmandu, Nepal. drtks@ccsl.com.np. **Impact of anthropogenic stress on rare ornamental fish of head water Ganges of Nepal**

Habitat changes continue to have major impact on the distribution abundance of many fish by mountain streams. Reservoir fishes of mountain streams are perhaps the least studied and poorest known natural resources. Dam and reservoirs have drastically changed fish habitat and communities, and have blocked both up river and down river migration of pristine Himalayan fishes such as mahseers (*Tor putitora, Tor tor, Acrossocheilus heaxagonolepis*) and snow trout (*Schizothorax richardsonii, S. plagiostomus, S. esocinus* and *S. progastus*). Many upland habitats disturbed by dams and fishing activities are less congenial for reheophilic fishes such as *Psilorhynchus pseudocheneis, Balitora brucei, Glyptothorax pectinopterus, Pseudocheneis sulcatus, Botia almore, Nemacheilus beavani* etc. General problems of fishery management and conservation of rare species in Himalayan rivers are carefully reviewed. Possible management solutions by creating Himalayan aquaria and river parks are discussed at length.

CHAUDHARY, U. K., ANKUR, K. & SHUKLA, R., Civil Engineering Department, Institute of Technology, Banaras Hindu University, Varanasi-221 005, India. rishi1shukla@yahoo.com. **Vanishing essence of the mighty River Ganga**

Degradation in drinking water quantity and quality over the complete stretch of the River Ganga is of serious concern. Existing species are continuously deteriorating and various medicinal plants have been lost. Dissolved Oxygen content of the river water has fallen well below the permissible limit and water borne diseases have increased. Unregulated withdrawal of water, disposal of pollutants, and fluctuations in water level are very critical problems. Technical assessment of water treatment plants to where, how much and how to release pollutants is required. Reductions in water level, for example, can cause a reduction in velocity, which leads to reductions in dissolved oxygen. Water quality is further deteriorated by enhancing the rate of pollutant flux. The interaction between pollutant flux and river water deteriorates the momentum and energy of the natural flow. In this process, streamline patterns gets distorted. The above problems need to be dealt with on a priority basis. Low cost, sustainable solutions can be achieved based on a river energy concept. In the present paper, variations in water quality and quantity of the Ganga at Varanasi over a stretch of about eight kilometres are discussed in terms of biodiversity and environmental degradation with respect to changes in river dynamics.

SINGH, K., BISWAS, N., BALPURE, S. & SHRIVASTAVA, P., Department of Limnology, Barkatullah University, Bhopal. singh_kajal_bpl@yahoo.com. **Studies on biotic diversity of Macroinvertebrates in central zone of Narmada River**

Narmada is the largest west flowing river of the Indian peninsula, originating from the ease. at Amarkantak, then flowing west and joining the Arabian sea. The Narmada basin covers an area of 96786 sq. km. It is fed by 41 major tributaries. Besides the tributaries there are 50 rivulets and 17 water pools. It is an aquatic ecosystem with great biodiversity and home to many endemic & rare species. The main aim of the present study is to assess the status of benthic biodiversity in the Narmada basin. The biotic diversity of Macroinvertebrates was explored at two tributaries (Dudhi, Korighat) and three reservoirs (Tawa, Kolar, Barna) falling in the Central zone of Narmada Basin. Quarterly sediment samples were collected with the help of Petterson grab, and Serber samples were collected from shallow region. Separation of benthic organisms was done by using different mesh size sieves. From these samples, qualitative and quantitative estimations of benthos were made. A total of 45 species of benthic invertebrates have been reported from this region, including 2 species of Bryozoa, 4 of Annelida, 22 of Arthropoda and 17 of Mollusca. The present study shows that the macrobenthic community is clearly dominated by Class Insecta with 19 representative species, followed by Class Gastropoda with 14. Amongst the reservoirs, Tawa reservoir has shown the lowest density ranging from 36-87 org /sq.ft. and the highest diversity (19 sp.) These findings indicate the healthiest ecosystem due to least anthropogenic activities, and low organic matter input. Both the tributaries have shown low diversity (14 sp.) and high density (34-109 or/sq.ft.) revealing the most polluted zones due to many religious and anthropogenic activities on the banks.

SINHA, R. K.[1], SHARMA, G.[2], KEDIA, D. K.[1], SINHA, P.[1] & KHAN, K. M.[3], [1]Environmental Biology Laboratory, Zoology Department, Patna University, Patna 800 005 India; [2]Zoological Survey of India, Gangetic Plains Regional Station, Patna; [3]Wildlife Trust of India, New Delhi.
Zooplankton diversity in the River Ganga in Bihar

A total of 69 species of zooplankton comprising 41 rotifers (59%), 20 cladocerans (29%) and 8 copepods (12%) were identified in 54 samples collected using bolting silk net from the River Ganga between Buxar and Maniharighat (approx. 500 km) in Bihar State during six continuous surveys from October 2003 to June 2005. The samples were collected from nine sampling points during winter (February-March), summer (April-June) and post-monsoon (October-November) seasons. Winter is the leanest season for the Ganga. Among rotifers 51% of the taxa belonged to *Brachionus* spp., whereas *Alona* sp. alone constituted 25% among the cladocerans. Nauplii larvae were dominant copepods. The common rotifers were *Brachionus angularis, B. calyciflorus, B. budapestinensis, B. caudatus, B. falcatus, B. rubens, Asplanchna brightwelli, Filinia longiseta, F. opolensis,* and *Keratella tropica.* Out of 54 samples the highest species richness (28 species) and density (102 individual l^{-1}) were at Buxar in June 2004 with Shannon's index value of 1.334. Physico-chemical properties of the river water were also analyzed during the study. The range of pH was between 8.0 and 8.5 with an average value of 8.28, that of water temperature between 23 and 39 degree centigrade (average 28.9 degree centigrade), dissolved oxygen between 5.43 and 10.80 mg l^{-1} (average 7.96 mg l^{-1}), total alkalinity between 86 and 218 mg l^{-1} (average 131.5 mg l^{-1}), and total hardness between 102 and 217 mg L^{-1} (139.3 mg l^{-1}).

SINHA, R. K.[1], KHAN, K. M.[2], KEDIA, D. K.[1], KHAN, I. A.[1], SINGH, A. K.[1], SINHA, S. K.[2] & SHARMA, G.[3], [1]Environmental Biology Laboratory, Department of Zoology, Patna University, Patna. rksinha_54@sancharnet.in; [2]Wildlife Trust of India, New Delhi; [3]Zoological Survey of India, Gangetic Plains Regional Station, Patna.
Current status of Gangetic dolphins in the mainstream of Ganga in Bihar, India

The Ganges River Dolphin, *Platanista gangetica gangetica* inhabits the Ganga – Brahmputra – Meghna, and Sangu - Karnphuli River Systems of India, Nepal and Bangladesh. For the last few decades the species has been facing several threats and has been categorized as "endangered" by the IUCN. The Ganga river system constitutes a major distribution range of the dolphins in India. In the entire stretch of the Ganga, the majority of dolphin populations inhabit the stretch of the river in Bihar. Continuous surveys three times a year in different seasons were conducted in the Ganga in the stretch of 500 km one way in the State from Buxar to Manihari Ghat (Katihar) during 2003 – 2006, to study the population status of the species. Continuous upstream and downstream surveys were conducted using a motorized country boat. High, low and best estimates of the dolphins were recorded scientifically by a team of 7-8 observers. Best estimate of the dolphins in the upstream and downstream surveys ranged from 428 to 664 and 351 to 517 respectively. Encounter rates (no. of dolphins km^{-1}) varied in different stretches of the river in the State. In most of the surveys dolphin encounter rate was maximum in the Vikramshila Gangetic Dolphin Sanctuary between Sultanganj and Kahalgaon in a stretch of about 55 km. This paper discusses in detail the trend of dolphin population in Bihar during the last three years. Mean group size, estimates of dolphin population, encounter rate and number of dolphins in different age – classes have also been discussed.

SINHA, R. K. & GOKUL, B., Senior Lecturer, School of Environmental Engineering Vermiculture Lab, Griffith University, Nathan Campus, Brisbane, QLD-4111, Australia. Rajiv. Sinha@griffith.edu.au. **Vermi-filtration of sewage with synchronous treatment of sludge by earthworms : A low-cost decentralized system of sewage treatment proposal for River Ganges water shed**

Discharge of untreated sewage carrying high BOD and COD loadings and heavy metals into the River Ganges blatantly pollutes the holy river, affecting its aquatic biological integrity. Conventional methods of sewage treatment incur heavy expenditure on the establishment and maintenance of sewage treatment plants. Safe disposal of 'sewage sludge' is an additional burden. Sewage treatment plants have therefore, always failed in India. Vermi-treatment (vermi-filtration) of sewage is emerging as an ecologically sustainable and economically viable alternative being experimented with worldwide, including Australia, on a large scale. Earthworms are versatile waste eaters and decomposers and promote the growth of 'beneficial decomposer bacteria' in wastewater. They serve as 'biofilters'. Our studies have shown that they can remove BOD by 90%, COD by 80-90%, total dissolved solids (TDS) by 90-92% and the total suspended solids (TSS) by 90-95% from wastewater. The biggest advantage of the process is that there is 'no sludge formation', as the worms eat up all the solid particles. The process is also odour-free as the worms discharge anti-bacterial coelomic fluid inhibiting the action of anaerobic micro-organisms which release foul-smelling hydrogen sulfide and mercaptans. The resulting vermi-filtered water is clean and disinfected enough to be reused for farm irrigation and other non-potable uses. Vermi-filtration can prove to be a low-cost option for sewage treatment both efficient and convenient, to be used in a de-centralized manner in individual homes and institutions in developing countries. If homes and institutions in Indian cities situated along the holy River Ganges are also provided with this decentralized system, it could lead to prevention of pollution and conservation of the holy river.

SINHA, R. K.[1], SINHA, S. K.[2], KEDIA, D. K.[1] & SHARMA, G.[3], [1]Environmental Biology Laboratory, Department of Zoology, Patna University, Patna, India; [2]Wildlife Trust of India, Field Station- Valmiki Tiger Reserve, Valmikinagar, West Champaran, Bihar – 845107. samirksinha@rediffmail.com; [3]Zoological Survey of India, Gangetic Plains Regional Station, Patna. **Observations on some behavioral aspects of the Ganges River Dolphin, Platanista gangetica gangetica**

The Ganges River dolphins, *Platanista gangetica gangetica*, commonly known as susu, are blind freshwater dolphins, as their eyes are devoid of crystalline lens. Approximately 2500 individuals of the species are surviving in the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of India, Nepal and Bangladesh between tidal zones, and as far up as the rivers are navigable at the foothill of the Himalayas. Behavioural aspects of the susu were observed by a team of researchers at the Ganga– Gandak confluence at Patna every fortnight, eight hours a day, between October 2000 and March 2002, except during July-September of each year, the high flood season. Confluences are one of the preferred habitats of the dolphins. The data were collected on a well-designed format based on standard protocol, namely *ad libitum* sampling, during both individual and group followings. Dive–time/surfacing, mother-calf association, diurnal movement pattern, and feeding behaviour were observed and recorded. Adult dolphins showed more diversity in surfacing behavior as compared to young ones. The animals were found to be foraging during morning and evening times and thus were active. Though the species is solitary by nature compared to its marine counterparts, who are gregarious, the mother and calf remain together for one year.

MANJAPPA, S.[1], SURESH, B.[2], PUTTAIAH, E. T.[3], [1]Chemistry and Environmental Science and Technology Study Centre, Bapuji Institute of Engineering and Technology; [2]Research Student, Environmental Science and Technology Study Centre, Bapuji Institute of Engineering and Technology, Davangere-577004. Karnataka State, India. drsmdvg@yahoo.co.in, drsmdvg@hotmail.com; [3]Department of PG Studies and Research in Environmental Science. **Kuvempu University limnological study of Tungabhadra River near Harihar, Karnataka**

Algae are involved in water pollution in a number of significant ways. Pollution may bring about an enrichment of algal nutrients in water. The present investigation was carried out on limnology of Tungabhadra River near Harihar, Karnataka, India from May 2004 to April 2005, where both algal and water samples were collected from four stations and studied at monthly intervals The most pollution tolerant genera and species of four groups of algae namely, Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae were recorded in relation to physico-chemical parameters for four stations. The assessment of water quality of the river was then made on the above stations by algal communities in an attempt to find out the correlation of algal periodicity and physico-chemical parameters.

TARE, V., Environmental Engineering and Management Programme, Department of Civil Engineering, IIT Kanpur, Kanpur-208016, UP, India. vinod@iitk.ac.in. **Water quality changes in the middle stretch of the River Ganga and suggestions for a paradigm shift in the Ganga Action Plan**

It is generally believed that the River Ganga is getting polluted due to the discharge of wastes from domestic, industrial and agricultural activities, and its water quality needs to be improved. To achieve this, an action plan, popularly known as the “Ganga Action Plan” (GAP), was launched in June 1985. A large quantity of data concerning river water quality has been generated through some scattered independent studies in 1960’s and 1970’s, and more systematic monitoring programmes since the early 1980’s. This keynote address presents an analysis of data to assess the long term changes in the river water quality parameters. The concept of temporal and spatial variation in moving averages of the river water quality parameters has been used for assessing the changes. For this purpose the most critical (based on flow) and polluted (based on discharge of wastewaters) stretch, designated as “Kannauj – Kanpur Stretch”, was selected. It has been observed that on average river water quality in the entire stretch has remained unchanged over the past two decades. Thus, contrary to the general perception, changes in quality and quantity of discharge of wastewaters due to enhanced domestic, industrial and agricultural activities and/or some attempts of interception/diversion of wastewater with considerable investments seem to have made insignificant impact on the river water quality, particularly considering the most commonly used parameters such as DO, BOD, and coliforms. To bridge the gap between general perception and scientific measurement, and to make the GAP more effective, a paradigm shift in both assessment and implementation philosophy and tasks to be undertaken are suggested. It is stressed that an approach that has a judicious blend of traditional wisdom and modern scientific and technological advancements may prove to be effective.

TRISAL, C.L. & KUMAR, R., Wetlands International – South Asia, A-25, 2nd Floor, Defence Colony, New Delhi – 110 024. wisaind@del2.vsnl.net.in. **Integration of floodplains into management of River Yamuna in Delhi Stretch**

Floodplains of the River Yamuna in Delhi Stretch were assessed for water quantity and quality in relation to biodiversity. Longitudinal and lateral flows of water in the river stretch, as well as water quality, essentially determine inundation of floodplains and characterization of biodiversity, Species richness was drastically reduced at the sites subjected to sewage outfalls. Most of the species present were either tolerant to the rigorous chemical milieu or had wide ecological amplitude. Co-inertia analysis demonstrated a grading of concordance between species datasets and water quality datasets. Benthic fauna exhibited the highest degree of correlation with water quality compared to planktonic communities, while the influence of water discharge was more pronounced in the case of planktonic species. The analyses of continuity/discontinuity of biodiversity indicated significant heterogeneity within the river stretch. The curves of species gain exhibited anomalous changes in gradients due to introduction of species from lateral habitats. Higher gains in species in zone 1 were attributed to occurrence of maximum number of water bodies in this zone. Inundation of floodplain area at Okhla is contributed to enhanced biodiversity at this site. Overall assemblages of 29 species including 19 benthic, 4 zooplanktonic and 6 phytoplanktonic species were identified as representing water quality characteristics and could be effectively used for monitoring along with the physico-chemical parameters of water. Allocation of water for maintenance of floodplains is critical to improving water quality and enhancing biodiversity. Recommendations have been made to designate floodplains as ecologically fragile areas and to integrate conservation and sustainable use of floodplains into Yamuna River basin management.

TRIVEDI, R.C., Central Pollution Control Board, East Arjun Nagar, Delhi – 110 0-32, India. adrct.cpcb@nic.in. **Water quality management in India**

The ever increasing water demand and uneven distribution of rainfall over time has lead to severe water scarcity and quality degradation in India. Discharge of untreated domestic wastewater is a predominant source of pollution. The estimated sewage generation is far more than the sewage treatment capacity. Municipalities and other civic authorities are not able to cope up with this massive task, due to lack of resources, erosion of authority, and inadequate managerial capabilities. The regular monitoring results indicate that organic and pathogenic pollution are the major water quality issues of India. Thus it became necessary to launch the Ganga Action Plan and subsequently the National River Action Plan, which essentially address the tasks of trapping, diverting and treating municipal wastewater. A similar situation exists for wastewater generated from all major industrial sources; in that there is a large gap between generation and treatment of wastewater from these sources as well. This has lead to the accumulation of wastewater in urban/industrial areas which percolates in the ground and pollutes the groundwater, the only source of drinking water in many cities. Several efforts have been made by the government of India to restore water quality of the national aquatic resources. A series of legislations were enacted and a large number of institutions were established. As well, several incentives and mutually agreed upon programmes were implemented. A brief overview of all these measures and activities will be presented.

NAUTIYAL, P.[1], VASHISTA, P.[2] & DHASMANA, P.[3], [1]Department of Zoology, H N B Garhwal University, Srinagar, 246174, Uttaranchal, India; [2]Government P. G. College, New Tehri, Uttaranchal, India; [3]Department of Zoology, M. K. P.College,Uttaranchal, India. **Length-weight relationship in coldwater fishes of Himalaya**

The length-weight relationship was determined for *Tor putitora*, *Schizothorax richardsonii* and *S. plagiostomus* inhabiting the coldwater glacier-fed rivers of the Gangetic drainage in Himalaya, and compared with other coldwater and temperate species. Length-weight relationship was best expressed in parabolic form for these species. Weight of females increased at a faster rate than males. Growth was allometric in *S. richardsonii*, while isometric in *S. plagiostomus* and *T. putitora*. Trout and common carp from the northern hemisphere revealed near cubic growth; however, in most of the fishes of Kashmir, the growth was not cubic.

VASS, K.K., Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, West Bengal, INDIA. kuldeepvass@rediffmail.com. **Status and scenario of riverine fisheries in India with reference to Ganges**

The river systems of India are comprised of 14 major rivers (catchments > 20, 0000 km^2), 44 medium rivers (catchments 2,000-20,000 km^2), and numerous small rivers and streams. The major river systems of India can be divided broadly as: (i) Himalayan river system (Ganges, Indus and Brahmaputra), and (ii) Peninsular river system (East Coast and West Coast river system). Among the large rivers, River Ganges is the largest. Therefore, the status of fisheries and prospects of this important river system are examined here vis-à-vis different ecological changes. The river system harbours about 265 fish species, out of these 34 species are of commercial value including the prized Gangetic carps, large catfishes, featherbacks and murrels. In the mountain region, from source to Hardwar the fisheries are dominated by *Schizothorax* spp., catfishes, mahseer and *Labeo* spp. The commercial fisheries assume importance in the middle stretch of the river (Kanpur to Farakka), for which the mainstays are the species belonging to Cyprinidae and Siluridae. The fisheries of River Ganga have shown perceptible qualitative and quantitative changes responding to the anthropogenic alterations occurring in the river. The average fish landings from selected centres of River Ganga reveal that in the upper (Kanpur and Allahabad) and middle stretches (Buxar, Ballia and Patna) the landings during last four decades declined from 119.35 t to 78.15 t and 69.53 t to 20.58 t respectively with slight increase from 66.77 t to 88.73 t in the lower stretch (Bhagalpur and Lalgola). Thus the total average fish landing from the Ganga river system (Kanpur to Lalgola) declined from 85.21 t to 62.48 t. A shift in predator prey relationship is also evident indicating signs of disturbance in fish hierarchy. Fish seed availability index also declined in the middle stretch indicating lower degree of fish recruitment and breeding failure. The signs of climate change are also discernable. This shift in fisheries in the Ganges has been examined vis-à-vis the changes in water availability, its diversion to dams/barrages, and deterioration of selected stretches. It is suggested that an integrated ecosystem management approach is needed to arrest the decline of inland fisheries in River Ganga.

VASS, K.K., DAS, M.K., MUKHOPADHYAYA, M.K., KATIHA, P.K., MAJI, S., DEY, S. & SRIVASTAVA, P.K., Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, West Bengal, INDIA. kuldeepvass@rediffmail.com. **A time series assessment of the status of fisheries of River Ganga**

The fisheries of the River Ganga have shown perceptible qualitative and quantitative changes in response to man-induced alterations. Data on various aspects of the inland fisheries including landings, seed availability, plankton, and fish species distribution, from 1959 to 2004, was examined. Time series data were subject to statistical analysis to determine trends. In the upper (Kanpur and Allahabad) and middle stretches (Buxar, Ballia and Patna) average fish landings declined from119.35 to 78.15 tonnes, and from 69.53 t to 20.58 t respectively, with a slight increase from 66.77 t to 88.73 t in the lower stretch (Bhagalpur and Lalgola). Qualitative analysis shows an increasing percentage of catfish from 26.2% to 41.7%, and a decrease in miscellaneous fishes from 56.1% to 36.8%. A shift in predator-prey relationship is also evident indicating a disturbed ecosystem. Total plankton availability declined from 2968 units l^{-1} (1966) to 410 units l^{-1} (2004) indicating reduced food resources. Qualitatively, the number of phytoplankton genera declined from 49 (1959) to 44 (1996) and zooplankton from 38 to 26. A decrease in rainfall runoff, coupled with higher siltation resulted in the alteration of the flow pattern and turbidity essential for breeding Indian major carps. Further sandfication (79 to 99%) of the river-bed up to Patna, has resulted in a loss of biological productivity. It is suggested that an integrated ecosystem management approach is needed for arresting the decline of inland fisheries in River Ganga.

VERMA, P., & NATH, A., Department of Zoology Patna University Patna, Bihar. drprakriti@sify.com. **Variations in protein, carbohydrate and lipid content of fish muscles due to aquatic pollutants from River Ganga**

Wealth of aquatic resources is assumed to be an unlimited gift of nature. Our Holy River Ganga has diversified aquatic fauna and is known to harbour more than 250 species of fish including Gangetic major carps, large cat fishes and several others. However, these aquatic fauna especially fish, are under severe stress due to habitat destruction, pollution, and indiscriminate fishing in terms of both quality and quantity. For the present investigation, fish like catla, mrigal, rohu and catfish were collected from sites randomly selected from different parts of Patna. Quantitative estimation of protein, lipid and carbohydrate was done by adopting the methods of Lowry, Umbreit and Barns & Black- Stock. It has been observed in the present study that there are significant variations in the concentration of total protein, carbohydrate and lipid content in fish species. Histopathology of caudal muscular cell and liver cell show high degeneration at sub cellular level. Increased levels of serum Thyroid Stimulating Hormone (TSH) also confirms the toxic condition of fish, as serum TSH levels serves as bioindicators of aquatic toxicity. Imbalance in TSH levels leads to dysfunction of various physiological disorders. As a whole, elevated TSH levels alter biochemical pathways through neuroendrocrine control which ultimately affects the protein synthesis and lowers the nutritional value of fish. Thus it is an urgent need to evaluate the nutritional status of Gangetic fish in terms of quality and quantity. The present investigation was therefore undertaken to elucidate quantitative variations of total protein, carbohydrate and lipid levels of muscle and liver of fish, and to evaluate their nutritional status.

WAKID, A., DAS, S., CHETRY, D. & DAS, C., Gangetic Dolphin Research and Conservation Programme, Aaranyak, 50, Samanwoy Path, Survey, Beltola, Guwahati – 28, Assam, India. wakid@rediffmail.com **Population status of Gangetic dolphin (*Platanista gangetica*) in Brahmaputra River within Assam: Is it declining?**

Brahmaputra River within Assam is one of the major habitats of endangered Gangetic dolphin (*Platanista gangetica*) in the world. To fill the gap of information on the current status of the species, we conducted a population survey of this species across a 856 km stretch of the river from Assam-Arunachal Pradesh border to India-Bangladesh border during February-April, 2005. We have recorded altogether 197 dolphins in the entire river with an encounter rate of 0.23 dolphins per km. We observed a significant difference in numbers between dolphin calves and adults. A comparative analysis indicated a possibility of declining population at the rate of 26% over the last 12 years. Accidental killing through gill net entanglement, poaching for oil, habitat degradation and ongoing power plant construction were identified as the main factors responsible for the declining population. Involving the local communities in the conservation of dolphins and their habitats through awareness campaigns and capacity building were identified as the most appropriate initiatives for the long term conservation of these dolphins.

YAHYA, H. S. A., Department of Ornithilogy and Wildlife, Aligarh Muslim University, Aligarh, India. **Conservation of Indian aquatic avifauna verses health and management of the Gangetic ecosystem**

As is the case with many other biodiversities, sustenance of over fifty percent of Indian avifauna is directly or indirectly dependent on availability and quality of water. The River Ganga passes through several north Indian states and creates temporary or permanent habitats for a majority of north Indian aquatic birds. Feeding and breeding biologies of large number of land birds are also influenced in many ways during flooding and receding times of the Ganges. A large number of wetlands and reservoirs of north India, more particularly in states of Uttar Pradesh, Bihar and West Bengal, which provide refuge to millions of migratory birds, are part of Ganges river basin. It is thus quite natural that conservation of most aquatic fauna in these areas is directly related to the health and management of this majestic river and its tributaries. However, despite various attempts of the government and non-government organizations to maintain the cleanliness of the Ganga, the river is becoming more and more polluted every day due to increasing anthropogenic pressures. Constructing bridges, converting wetlands to uplands, and construction of barrages and dams have further jeopardized the ecology of the river resulting in loss of habitat and movement of many fish, mammals and avian species. During the last quarter of the 20th century several projects have been conducted on the ecology, biology, population status and conservation of aquatic birds of Ganga's river basin. The present paper highlights the importance of healthy management of the Ganges for the sustainability of aquatic birds with particular reference to cormorants (*Phalacrocorax* spp.), egrets (*Egretta* and *Bulbulcus* spp.), Darter (*Anhinga rufa*), Sarus Crane (*Grus antigone*) and ducks (*Anas* spp.).

YOUSUF, A.R., MAHDI, M. D. & BHAT, F. A., Limnology & Fisheries Laboratory, Centre of Research for Development, the University of Kashmir, Srinagar – 190 006, J &K, India. aryousuf@rediffmail.com. **Ecology of *Schizothorax plagiostomus* Heckel in the Jhelum river system in Kashmir Himalaya**

In India the genus *Schizothorax* Heckel (Family Cyprinidae: Subfamily Schizothoracinae) is represented by a number of species on the northern as well as southern borders of the Himalaya, the majority being in Kashmir Himalaya. While *S. richardsonii* Gray & Hard has been reported from the upper reaches of the Ganga river system, its close relative, *S. plagiostomus* Heckel occurs in the upper Indus in Ladakh region as well as in the Jhelum river system in Kashmir Valley. Different aspects of the ecology of *S. plagiostomus* Heckel in the Jhelum (a tributary of Indus River) and its important tributaries in Kashmir region (Sundran, Lidder, Rambiara, Sind, Pohru, Buniyar and Haji Pir streams) were studied from 2002 to 2005 under the GBPIHED (Almora, Uttranchal) sponsored Research Project. The Jhelum, after its origin in the Panjal Range flows for a distance of 250km in Indian part of Kashmir before entering Pakistan held Kashmir. The concentration of various nutrients in the water is closely related with the anthropogenic pressure in different segments of the river. *S. plagiostomus* is distributed throughout the river length in the State of Jammu & Kashmir, especially in the fast flowing areas. The fish is a benthic herbivore and feeds mainly on periphytic diatoms. Throughout its course, *S. plagiostomus* forms an important component of the commercial fishery in the River Jhelum (Kashmir). However, in the slow flowing zones its contribution is low, which seems to be related to water current, competition with lacustrine fish, and the anthropogenic pressure on the river.

ZHANG, Y., Nanjing University, Nanjing 210093, Nanjing Institute of Environmental Science, Nanjing 210042. zhangymzym@163.com. **Analysis of environmental impact on first stage project of South –North Water Diversion of China and control measures**

The South–North Water Diversion Project is part of the great Hydraulic Engineering Division in China. It consists of the Western Route Project (WRP), Middle Route Project (MRP) and Eastern Route Project (ERP). ERP aims to reroute the water from Yangtze River at Shanjiangying County in Jiangsu Province , transfer it by way of the Liyun River, Shanyang River, Subei Irrigation Chief Trench and Huai River until it, reaches Shandong, Hebei, Tianjing Province where there is a severe lack of water. The first and most important stage of the ERP involves the construction of the Shanyang, Tong and Baoying rivers pump station. This paper analyzes the impact of environmental factors during the period of construction and first stage project of ERP, on the water, ecological system, air and social environment. The treated effluent of silt discharge, domestic sewage and oil wastewater by construction machinery will pollute the water body to some extent. The land excavating, pushing down and expropriation will affect the ecological environment. There is less impact on the air and sound environment in the construction, and it will result in improvement in agricultural production, irrigation and drainage conditions, and transportation during the working of the project. It suggests that more control measures should be taken to mitigate and avoid the adverse environmental impacts.

Poster Abstracts

Alphabetical by presenting author

ALAM, S., MUKHERJEE, P., SARDAR, D., KOLE, R.K., BANERJEE, H. & SENGUPTA, M.[1], Water Quality Monitoring Laboratory, Department of Agricultural Chemicals, Bidhan Chandra Krishi Viswavidyalaya, Kalyani – 741235, West Bengal; [1]National River Conservation Directorate, Mins. of Environment & Forests, New Delhi, India. **Status of pesticide residues occurring in sewage sludge produced by various sewage treatment plants located in some districts of Gangetic West Bengal**

Residues of Organochlorine (OC) pesticides like HCH (α, β, γ and δ isomers), DDT (op & pp isomers along with its metabolites pp-DDE and op-DDD), Endosulfan (α and β isomers along with its metabolite endosulfan sulfate) and Organophosphorus (OP) pesticides like Dimethoate, Malathion and Methyl parathion were monitored during 2002 -04 in 101 sludge samples collected from different Sewage Treatment Plants (STP) constructed under Ganga Action Plan Phase-1 in West Bengal. Samples were air dried, processed and a representative 10 g sample was mixed with 10 g anhydrous sodium sulfate, 0.3 g florisil, 0.3 g charcoal and extracted in a soxhlet apparatus using n-hexane and acetone (9:1) mixture for 6 hours. The residues of pesticides were estimated by Gas Liquid Chromatography (GLC) using Electron Capture Detector (ECD). Total HCH was detected in 93 samples, Total DDT in 85, Total Endosulfan in 83, Methyl Parathion in 13, Dimethoate in 21 and Malathion in 41 samples in the range of 0.06-9.270, 0.009-1.336, 0.010-0.730, 0.394-63.567, 0.157-12.02 and 0.026-5.04 mg kg^{-1} respectively. Total OC pesticides have been detected in 97 samples in the range of 0.025-9.560 mg kg^{-1} and total OP pesticides detected in 61 samples (0.026-63.567 mg kg^{-1}). Some of the isomers of HCH, DDT and Endosulfan exhibited significant differences in their residual content due to time of the collection of the samples. However, there was no variation observed due to the variation of the sampling location. The results of these in detail and their possible environmental implication will be discussed.

ALI KHAN, M.A., ALI KHAN, I. & ASHWANI, K., Environmental Science Lab, Department of Botany, Kisan P.G. College, Simbhaoli-245207(Ghaziabad), maalikhan@rediffmail.com **Physiological effects of distillery effluent on Majestic river ganga and its restoration through Ferti-irrigation for sustainable development**

Ganga water is used in religious rituals for purification of body, and soul – a well-known symbol of spiritualism in the Indian subcontinent. It originates from the Glacier of Gangotri-Bhagirathi-lap of the Himalayas. Water supply is continuously renewed through nature's hydrological cycle. However, distillery effluent, sewage, half burned dead bodies and ash are being discharged directly into majestic river Ganga, or through tributaries in Indogangatic plain, which have deteriorated water quality and biodiversity. Water samples from Garhmukteshwar-Bridgeghat (Thirthnagri), Ghaziabad (U.P) were collected and physico-chemically analysed for B.O.D., C.O.D., D.O., T.D.S., T.S.S, and pH. Enhanced numbers.of blue green algae *(Oscillatoria)* and decreased numbers of green algae *(Spirogyra),* as well as decreased numbers of dolphins and migratory birds were observed. Physiological effects of effluent were observed on *Hydrilla*, *Salvinia* and *Pistia* samples in varying concentrations (1,3,5%) when compared with a control. The strategy of ferti-irrigation technology shows improved organic carbon, available phosphorus, potassium, water holding capacity, microbiota and earthworms in soil and shows significant higher growth and yield of crops for sustainable agriculture. Thus it has decreased point organic load of the Bagad river tributary of holy Ganga and has been discussed as a clean development mechanism (CDM) for Gajraula Ecocity. It would eliminate mosquitoes' breeding centres, and would also provide 2-3 millions jobs for youths, thus fulfilling the demand of a long term plan (2002-2007). In spite of unexpected hurdles, this disposal technology in 295 distilleries combined with a reverse osmosis system would assure an impact on the Ganga Action Plan, sustainable development and a 10% growth rate for a developed 'New India'.

ANUPAMA & GUSAIN, O.P., Freshwater Biology Laboratory, PO Box 60, Department of Zoology, HNB Garhwal University, Srinagar-Garhwal 246 174 Uttaranchal. anurawat032753@gmail.com. **Habitat degradation of Himalayan mahseer in an Upper Ganges tributary**

The Himalayan mahseer, *Tor putitora* (Hamilton), a natural inhabitant of the River Ganga, frequents the spring-fed tributaries in its upper section. River Nayar in Garhwal Himalaya is one such favourable breeding ground of Himalayan mahseer. Of the various reasons cited for its decline, increased anthropogenic activities in the breeding ground have led to the deterioration of natural habitat of the fish. Massive quarrying of the river-bed has altered the substrate composition of its breeding and feeding ground. The shallow depressions created on the banks due to mining are flooded during rainy seasons. The 0+ year life stages of mahseer get entrapped in them with the subsequent lowering of the water level, causing mortality of the young fries. In addition to this habitat fragmentation, indiscriminate fishing, particularly of juveniles using spurious methods like poisoning and dynamiting impose further constraint to the survival of this threatened/endangered species. Data on microhabitat of juveniles of Himalayan mahseer were obtained under the present study. For the purpose, some potential abiotic parameters viz., temperature, velocity, discharge, turbidity, pH, dissolved oxygen, free CO_2, total alkalinity, etc. of water in the river along with the substratum composition were recorded along with biotic parameters viz., plankton, periphyton and macrozoobenthos. Based on the present observations, some ameliorative measures are discussed to protect the Himalayan mahseer. These include strict imposition of fishing regulation especially during breeding season, creation of sanctuary pools, creating public awareness among the local masses and establishment of a hatchery in the vicinity to propagate this dwindling species.

TANUJA & BEDI, S., Dept of Botany, B. M. D. College, Dayalpur, B.R.A. Bihar University; Dept of Industrial Microbiology, Patna Women's College, Patna University. **Isolation of antibiotic resistant coliforms from River Ganga in between Varanasi and Patna**

The River systems in India can be classified into four groups viz. Himalayan Rivers, Deccan Rivers, Coastal Rivers and Rivers of Inland drainage basins. River Ganga is an important Himalayan River formed by the melting snow and glaciers and therefore continuously flows throughout the year, traversing through Uttaranchal, Uttar Pradesh, Bihar and West Bengal states. Though revered in Hindu mythology, it is extensively exploited for almost every use. Frequent waste water disposal, industrial discharge, direct discharge of untreated and partially treated sewage and direct faecal discharge has lead to outbreaks of water-borne enteric diseases such as, cholera, typhoid, infectious hepatitis etc. caused by coliform groups of bacteria. Biological pollution from human excreta has lowered the quality of water directly and is a matter of deep concern. Since these groups of coliforms are a potential risk for health and antibiotic resistant strains further accentuate the problem, the present investigation to isolate and study antibiotic resistant coliforms was done by sampling the Ganges water from the popular ghats of Varanasi and Patna. Plating on McConkey agar and Eosin-Methylene blue agar as well as presumptive confirmed and completed tests indicated the presence of three most common coliforms viz. *Escherichia coli, Enterobacter aerogenes* and *Klebsiella* spp. amongst others. Isolation of the antibiotic resistant strains was done by the disc method. Bacterial strains were further tested against a battery of antibiotics for their resistance pattern and this showed that 25% of the coliform cultures were multiple antibiotic resistant. The Biological Oxygen Demand, Chemical Oxygen Demand, Chloride, Nitrate and Phosphate contents were determined by the standard methods. The study indicated the need for the development of a viable system with regular surveillance of the microbial population for ascertaining the correct microbial load in order to effectively combat the multiple dangers of anthropogenic pollution of the river body.

CHOUDHARRY, S., AHMAD, S., KUMAR, C. & AKHTAR, A., Plant Pathology and Microbiology Lab., P.G.Deptt. of Botany, Patna University, Patna-5. csharfuddin@yahoo.com.
A study of the diversity of Mycoflora of Ganga River from Danapur to Mokama (Bihar)

A frequent discharge of sewage in the River Ganga and a periodic inundation/ recession of annual flood water depositing silts, has drastically affected the ecology of Ganga River. Consequently the present investigation was undertaken to survey the fungal diversity of Ganga and its soil. Soil samples were collected in an aseptic small plastic container from six different spots like Danpur, Gayaght, Fatuha, Bakhtiyarpur, Barh and Mokama during July 2004 to June 2006. Collections were made from three different regions of the Ganga bed, i.e. river bank, river sand bed and muddy regions and brought to the laboratory the same day for fungal analysis. The fungi were isolated using soil dilution plate technique on different medium supplemented with suitable antibiotics. The isolated fungi were identified with the colour, texture, growth pattern of the colony, their photographs and by the microscopic observation of prepared slides and their microscopic photographs. The features observed were then compared with the authentic literature and confirmed. Around fifty fungi of different groups were identified. The seasonal variation in the frequency of the fungi were found to be regulated by many factors like temperature, humidity, soil chemistry, pollutants, dissolved oxygen etc.

GARG, R.K., SAKSENA, D.N. & RAO, R.J., Aquatic Biology Laboratory, UGC-SAP (DRS) & FIST Supported, School of Studies in Zoology, Jiwaji University, Gwalior (M.P.)-474011. eiaju@yahoo.co.in. **Monitoring of water quality of Chambal River at Palighat, Rajghat and Baraighat in National Chambal Sanctuary, Madhya Pradesh and its suitability as habitat for aquatic animals including endangered species**

Management of any aquatic ecosystem includes the conservation of freshwater habitat with an aim to maintain the physico-chemical quality of water. Before any step for aquatic ecosystem management and conservation is taken, the monitoring of water quality is prerequisite. Therefore, this paper aims to study the physico-chemical characteristics of Chambal river water along with its suitability as habitat for aquatic animals. The stretch of Chambal River contained in the National Chambal Sanctuary (located at 25°00'N-26°30'N, 79°15'E-75°40'E) extends up to 600 km downstream from Kota (Rajasthan) to the confluence of the Chambal with Yamuna River. The river flows in Madhya Pradesh spans up to approximately 400 km. Three sampling stations were established for the collection of water samples during April, 2003 to March, 2004. The physico-chemical characteristics of the water were analyzed according to the methods of APHA (1985) and Trivedy and Goel (1986). Various physico-chemical characteristics of water including water temperature, depth, color, transparency, flow rate, pH, dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, chloride, calcium and magnesium were determined at the sampling stations, while other parameters including turbidity, electrical conductivity, total dissolved solids, nitrate, nitrite, sulphate, phosphate, silicate, biochemical oxygen demand, chemical oxygen demand, ammonia, sodium and potassium were analyzed in the laboratory within 4 to 6 hours of collection. Analysis of the water quality parameters reflected the pristine nature of the river in National Chambal Sanctuary. On the basis of various parameters studied, Chambal River in the sanctuary area is pollution free and can serve as a good habitat for many aquatic animals including endangered species.

GUSAIN, O.P., PRAKASH, M., & RAGHAV, D., Freshwater Biology Laboratory, PO Box 60, Department of Zoology, HNB Garhwal University, Srinagar-Garhwal 246 174 Uttaranchal. ogusain@yahoo.com. **Density, distribution and diversity of benthic macroinvertebrates: a case study of a watershed in the Upper Ganga region (Garhwal Himalaya)**

Small watersheds with numerous streams and rivulets are characteristic topographic features of the Upper Ganga. The present study deals with one such watershed, Khanda Gad, in the Garhwal Himalaya. Benthic macroinvertebrates are the important secondary producers in hillstreams and act as indicators of the health of the rhithronic stretch of Upper Ganges. Surveillance of density, distribution and diversity of benthic macroinvertebrates in eight streams belonging to first to fifth stream orders revealed that their diversity comprised of 20 genera belonging to 18 families and 7 orders of class insecta (phylum Arthropoda) along with two molluscan genera. The seasonal density of benthos varied between 122.6 ±8.91 and 795.0 ±52.3 Ind. m^{-2}. Shannon diversity index ($\overline{H}$) ranged between 0.56 and 0.96, which showed the poor health of the watershed. The concentration of dominance (*C*) ranged between 0.12 and 0.35; richness index between 2.67 ±0.3 and 7.369 ±0.36; and evenness index between 0.22 ± 0.01 and 0.35 ± 0.02 during the present study. The similar pattern of seasonal distribution of benthos in the streams is supported by the high values (47.36 to 100%) of similarity index (SC_J). Alpha-diversity, similar among all streams, varied seasonally. Low beta diversity (1.16-1.33) showed that species composition does not differ with stream order. The study showed that human modification of the watershed in terms of deforestation and more importantly abstraction of water for drinking and irrigation have affected the distribution and abundance of benthic macroinvertebrates. Also, changes in agriculture have caused environmental degradation in the watershed, which has reduced the discharge of the springs.

JHA, B.C., Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, West Bengal, INDIA. jha_bc@yahoo.co.in. **Assessment of algal diversity in the lower reaches of river Ganga including the Bhagirathi**

Extensive field surveys for collecting algal flora in the lower reaches of river Ganga including the Bhagirathi were conducted during 2000-2005. Algal samples, plankton, periphyton and spray-zone flora, were collected using standard methodologies. Identification of algal taxons was done following standard keys. Digital photographs of each species were taken and stored as record.

A total of 453 species of algae belonging to Cyanophyceae, Chlorophyceae, Bacillariophyceae, Dinophyceae, Xanthophyceae, Euglenophyceae and Rhodophyceae have been recorded from different sampling sites. Efforts have also been made to collect data on environmental variables simultaneously in order to correlate them with algal diversity. A comprehensive spectrum of the identified algal flora has been prepared.

JOSHI, K. D., Riverine Division, Central Inland Fisheries Research Institute (ICAR), 24 Panna Lal Road, Allahabad-211 002, Uttar Pradesh, India. kdjoshi_nrccwf@rediffmail.com. Status of fisheries resources in the rivulet Ladhiya, an upland tributary of the Ganga river system

The rivulet Ladhiya, flowing through the Middle and Lesser Himalayan belts of the Central Himalaya in district Champawat (Uttaranchal, India), is a tributary of the Ganga river system. The rivulet is perennial, spring-fed and represents typical hill stream characteristics. It originates at an altitude of 2,110 msl, traverses over 75 km distance through the varied catchments spread over 24,602 ha and finally joins the mighty river Kali at 410 msl. The study was conducted during July 1997 to June 1998 through monthly samplings at 3 selected sites. The water velocity and volume in the rivulet varied from 0.25-1.0 m sec^{-1} and 44.50 - 5352.30 ft^{-3} sec^{-1}, respectively. The values of water temperature and dissolved oxygen were found to range between 11.3-29.6 8° C and 7.2 –11.2 mg l^{-1}. A total of 10 fish species have been collected from the system during the course of study, in which all 10 were recorded from the lower stretch of the Ladhiya, 7 were also found in the upper stretch and 8 from its major tributary – Kwerala. The fishery in the rivulet is predominated by *Schizothorax richardsonii* (36.07%), followed by *Tor putitora* (34.25%), *Garra gotyla* (7.46%), and *Barilius bendelisis* (6.85). The experimental fish catch per unit effort (ECPE) from the rivulet varied from 0.0 gm – 42.2 gm. The riparian vegetation in the midstream catchments of the rivulet are severely eroded due to road construction, as a result the river carries a huge silt load that has degraded the substratum and filled almost all deep pools in its course. Owing to vanishing deep pools and over exploitation, the fishery of the rivulet, along with most of the upland tributaries of the Ganga river system has registered steady depletion.

KAR, D.[1], MANDAL, S. K., SUR, P., KOLE, R. K., DAS, D. K. & DALWANI, R.[2], [1]Department of Agril. Chemicals and Department of Agril. Chemistry & Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741 235, West Bengal; [2]National River Conservation Directorate, Mins. of Environment & Forests, New Delhi, India. **Assessment of heavy metals pollution occurring in sediments of the river Ganga in West Bengal**

A study was conducted to estimate the level of heavy metal concentration in the bottom sediment of the river Ganga in West Bengal. Samples (48) were collected quarterly from four permanent monitoring stations along the 300 km stretch of the river during 2002 – 2005 and analysed using AAS. The pH and organic carbon of the samples were obtained in the range of 7.18 – 8.92 and 0.3 – 9.2 %. The concentrations of Fe, Mn, Zn, Cu, Cd, Cr, Pb and Ni were detected in the range of 1.20 – 1840.00, 1.60 – 1235.00, 0.80 – 77.20, 0.40 – 22.05, 0.05 – 1.60, 0.05 – 179.50, 0.59 – 150.0 and 1.60 – 29.00 µg g^{-1} respectively. Among the four locations, highest mean concentrations of Fe (560.25 µg g^{-1}), Zn (24.55 µg g^{-1}), Cu (8.9 µg g^{-1}), Pb (22.89 µg g^{-1}), Cd (0.65 µg g^{-1}), and Ni (16.48 µg g^{-1}) were observed in the sediments of Uluberia in the downstream whereas the highest concentrations of Mn (298.20 µg g^{-1}) and Cr (37.37 µg g^{-1}) were observed at Berhampore in the upstream. Most of the metals exhibited their lowest concentrations during monsoon or pre-monsoon seasons. The highest concentrations of Fe (570.70 µg g^{-1}), Cr (34.27 µg g^{-1}) and Ni (17.30 µg g^{-1}) were observed during the post-monsoon (Oct - Dec) season and for Mn (198.60 µg g^{-1}), Zn (28.40 µg g^{-1}) and Cu (9.16 µg g^{-1}) it was in winter (Jan - Mar). However Pb was highest in the pre-monsoon (Apr – June) season. There was no significant variation observed in the Cd concentrations of the sediment due to seasonal changes. Overall, the dominance of various heavy metals in the bottom sediment of the river Ganga followed the sequence: Fe > Mn > Pb > Cr > Zn > Ni > Cu > Cd.

SINHA, R. K.[1], PRASAD, K.[2], SHARMA, G.[3], & KEDIA, D. K.[1], [1]Environmental Biology Laboratory, Department of Zoology, Patna Unviersity, Patna 800 005 India. rksinha_54@sancharnet.in; [2]Department of Geology, Patna University; [3]Current Address: Zoological Survey of India, G.P.R.S., Patna. **Mercury load in the River Damodar in India**

The River Damodar is one of the largest non-Himalayan tributaries of the Ganga. Originating on Bodha hill in the west central part of Jharkhand state, it traverses for more than 500 km through the coal belts of the Gandwana deposits of Jharkhand before it discharges into the Hoogli River, the tidal zone of the Ganga in India, near Diamond Harbour. All along its stretch of about 300 km in the Jharkhand state there are coal mines or coal based industries, viz. thermal power plants, coal washeries etc. Water and Sediment samples of the river were collected in the lowest water season of May-June of 2004 at 19 locations 50 km downstream of the origin point of Durgapur in West Bengal to estimate the load of total Mercury (T-Hg). The samples were analyzed by cold-vapour methods using Mercury Analyzer Model No. MA – 5840 of Electronics Corporation of India. The average concentration of T-Hg in the sediments was 0.04 mg g^{-1} with a maximum of 0.068 mg g^{-1} below the Panchet Dam. More than average concentration was recorded at almost all the places between Bokaro Steel Plant and Panchet Dam, suggesting the influence of point sources. The maximum T-Hg concentration in river water was 0.001 mg l^{-1}. Although the mercury load was within permissible limit, due to in situ methylation of inorganic mercury even this low concentration of T-hg could increase the risk of contamination at higher trophic levels.

SINHA, R.K.[1], KHAN, K.M.[2], KEDIA, D.K.[1], SINHA, S.K.[2], & SHARMA, G.[3], [1]Environmental Biology Laboratory,Department of Zoology, Patna University, Patna - 800 005, India; [2] Present address: Wildlife Trust of India, A – 220, New Friends Colony, New Delhi – 110 065. khalid@wti.org.in; [3] Present address: Zoological Survey of India, Gangetic Plains Regional Station, Patna-800 016. **Avian diversity with special reference to waders in lower middle reaches of the River Ganga, India**

Altogether, 164 species of birds belonging to 43 families were identified, out of which 48.8% species were resident, 35.4% were winter visitor and 15.8% were resident / migrant. Continuous surveys both upstream and downstream were conducted in winter (February-March), summer (May-June) and post-monsoon (October-November) in the River Ganga in Bihar between Buxar in the west and Maniharighat (Katihar) in the east. This covered a distance of about 500 km, between April 2003 and November 2005 in order to assess the current status of the Ganges River dolphins and associated fauna in and along the river. During the survey, an emphasis was placed on recording the avian diversity along the Ganga in different habitats. The River receives four major and many minor tributaries in the stretch, resulting in high volume of water, vast floodplains and a large number of floodplain wetlands. Highly braided rivers and their continuously changing geo-morphological formations provide varieties of microhabitats which attract thousands of resident and migratory birds. In the recent past, environmental degradation of the River system due to rampant loss of vegetation, uncontrolled urbanization, population, and extensive farming on the floodplains has critically damaged the nesting and feeding grounds of birds. Apparently, the number and diversity of the migratory birds in the Ganga basin, especially in Bihar, have decreased in the last couple of decades. Habitats like MCI, CBI, braided channel, mudflat area, etc with low human activities are preferred roosting and feeding sites for almost all the waterfowl and waders of the River. Illegal poaching and bird trappings were identified to be the major threats to the avian fauna along the River Ganga in Bihar.

SHARMA, S.K., KUMAR, P., CHAUBE, U.C., MISHRA, S.K., & SHARMA, P., Dept. of Water Resources Development and Management, Indian Institute of Technology Roorkee, Roorkee (U. A.) – 247667, India. pradeep6dec@rediffmail.com. **Effect of regulated flow on benthic macroinvertebrates of the River Satluj**

The Nathpa Jhakri hydroelectric project (1500 MW capacity) is a 'run of the river' type project on the River Satluj (Himachal Pradesh). About 405 cumecs of water is being diverted by tunnel to an underground power house and then returned to River Satluj about 33 km downstream. This implies that there may be critical reaches in which reduced flows are not able to sustain the riverbed ecology. A field study was carried out to investigate benthic macroinvertebrates under pre and post-project flow conditions. The most pronounced effect of the flow alteration is seen on the macrobenthic insect fauna belonging to Trichoptera, Placoptera, Ephimeroptera and Chironomidaee. The dominant forms are *Hydropscyche* sp., *Chironomous pleumosus* and *Helius* sp. Large particulate feeders (shredders) have reduced, whereas the collectors have increased. The predominant oligochaetes are *Limnodrilus gracilis, L. profundicola, Tubifex tubifex* and *Dero forcata*. The molluscans species are *Thiara scabra, Vivipara bengalensis, Limnaea acuminate* and *Pisidium dubium*. During lean period of flow, stone flies have not been recorded. Most of the insect species have also decreased or are absent. The oligochaetes, however, are present during the lean period. The molluscan species such as *Pisidium dubium, Thiara scabre* and *Vivipara bengalensis* are also present. The occurrence of species dominance is correlated to availability of food and reproductive habits of the macroinvertebrates. This paper deals with the effect of water flow on macroinvertebrates of the River ecosystem. This study may be useful for sustenance of aquatic ecology of the River systems (including Ganga) where hydropower projects are in operation, construction or planning stage.

KUMAR, R., & SHARMA, K., Environmental Monitoring Section, Industrial Toxicology Research Centre, Lucknow. dasranjeet2@rediffmail.com. **A comparative assessment of water quality of River Ganga in Kanpur (U.P) and Patna (Bihar): a brief appraisal**

Holy Ganga River is a symbol of India's culture and is a lifeline of northern India. Ganga runs its course of over 2500 km from Gangotri in Himalayas to Ganga Sagar in the Bay of Bengal and passes through 29 cities and industrial areas. It receives large amount of untreated sewage and industrial effluents during its sojourn. The present study deals with the assessment of water quality of Ganga river in Kanpur City (88'22°E Longitude and 26'26°N Latitude) and Patna city (85'10°E Longitude and 25'37°N Latitude). Kanpur is a first major industrial city on the banks of Ganga during its journey from Himalays to the Bay of Bengal. Further, in each city two locations were selected upstream and downstream of the city, to asses the impact of city pollution. For assessment of water quality of Ganga in Kanpur city, Bithur is considered as upstream and Jajmau Bridge as downstream. Similarly, in Patna, Kurji as upstream and Ganga Bridge as downstream. The results revealed that concentration of most of the key parameters such as TSS, TDS, BOD, COD, total coliform (MPN per 100 ml) etc were higher downstream of both of the cities. In Patna, chemical pollutants were not very significant, but the bacteriological pollutants were alarmingly high due to indiscriminate discharge of untreated sewage. In Kanpur, chemical pollutants were also high due to tannery, textile and chemical industries. Overall, the water qualities with respect to prescribed standards were found more polluted in the downstream of both the cities. The probable reason is the discharge of large quantities of untreated industrial and sewage effluent. The irony is that the Ganga waters are synonymous with the divine purity and has over the years become entrenched in the country's psyche. However, the results measured at various points of the Ganga River are contrary to its general perception.

PRAKASH, S. & PANWAR, R.S., Riverine Division, Central Inland Fisheries Research Institute, 24, Panna Lal Road, Allahabad-211 002, Uttar Pradesh, India. **Impact of environmental modifications on the fishery, population and reproductive biology of Gangetic Prawns**

The fishery of freshwater prawns in River Ganga has declined to an alarming extent in the recent past. Not only the fishery has changed, but the population and breeding biology of prawns has been altered. The observations of 2003-05 have been compared with those recorded in 1982-85. Periodic visits to selected observation centers covering the middle and lower stretches of Ganga were conducted and random samples collected. A gradual decline in abundance of yearly catch was recorded. A bi-modal distribution in catch observed in 1982-85 has been modified to a uni-modal pattern in 2003-05. The ratio of males to females during the months of profusion was found to be 1:3, which appeared to decline to 1:1.4. The size at first maturity was observed to have increased from 60.0 mm to 70.5 mm. The number of juveniles per female was found higher during earlier observations as compared to later ones. The catches of females were similar to the sustainable yield in earlier observations, whereas it shows deflection in later cases. The length-weight relationship of males, females and juveniles indicated a non-linear relationship. The 'cube law' was applicable with slight modification i.e. the increase in weight was slightly higher than the cube of length. This observation highlighted a marked dependence of the index on food, sexual maturity and season. An average growth rate of 10-12 mm per month was observed in previous observation, which has declined to 5-6 mm per month. The fecundity/size relationship was found to be linear, but numbers of ova/egg per gram of body weight has become reduced in later years. It is assumed that the environmental modifications and over fishing have caused substantial hazards for the population and reproductive biology of all the species of freshwater prawns of the Gangetic ecosystem.

PRASAD, K.[1], SINHA, R.K.[2], DALWANI, R.[3], KEDIA, D.K.[2], SINHA, S.K.[4], RUKHAIYAR, S.S.[2], RANI, N.[2], KUMAR, V.[2], SINHA, A.K.[2] & KHAN, F.A.[2], [1]Department of Geology, Patna University, Patna 800 005 India. rksinha_54@sancharnet.in; [2]Environmental Biology Laboratory, Department of Zoology, Patna University; [3]National River Conservation Directorate, Ministry of Environment and Forests, Government of India, New Delhi; [4]Present Address: Wildlife Trust of India, New Delhi. **Water quality in middle-lower reaches of the River Ganga in Bihar, India**

Water quality of the River Ganga was monitored every month from January 1994 to December 2005 at five locations between Buxar (25°33'31N, 85°56'17E) and Rajmahal (25°03'22N, 87°50'25E) covering a distance of about 550 kilometer in the middle-lower reaches of the River in Bihar state. The parameters estimated were temperature, pH, turbidity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), chloride, nitrate, and total hardness besides bacteriological load of total coliforms and faecal coliforms. The data were pooled to calculate both annual and summer average of the different parameters in different years. The data have been compared between 1994 and 2004; and 1995 and 2005, i.e. at a gap of ten years to assess the extent of changes/improvement in the water quality. Average annual values of total coliforms, when compared, were found to have increased 26.33 and 22.88 times at Buxar, 2.1 and 15.98 times at Patna upstream, 5.6 and 13.1 times at Patna downstream, 11.06 and 15.16 times at Mokama and 17.17 and 8.49 times at Rajmahal, respectively. Similarly, fecal coliform increased 45.42 and 185 times at Buxar, 2.64 and 14.81 times at Patna upstream, 6.42 and 32.88 times at Patna downstream, 11.73 and 8.19 times at Mokama and 14.81 and 8.81 at Rajmahal. The physico-chemical characteristics depicted minor variation in the same period. The higher bacterial load may be attributed to ever-increasing floating urban population and increasing discharge of untreated domestic sewage. Details of factors affecting the water quality and measures adopted under the Ganga Action Plan for pollution abatement have been discussed in detail.

RAI, P.K. & TRIPATHI, B.D., Centre of Advanced Study in Botany, CSIR SRF, Banaras Hindu University, Varanasi-221005 India. prabhatrai24@yahoo.co.in. **Heavy metal and microbial pollution of the River Ganga: a case study at Varanasi**

Varanasi is the city that has grown around the Ganga, a city whose life and the life of its people are linked intrinsically with the River. The sacred city of Varanasi lies between the rivers Varuna and Assi on the banks of the Ganga, and is one of the oldest cities in the world. Due to ever increasing population and huge number of industries in and around the city, they are disposing off their waste waters into the municipal sewers as they do not have their own treatment plants. Every day out of 175 MLD of city sewage mixed with industrial effluent only 122 MLD is treated at three treatment plants i.e. 12 MLD at Diesel locomotive Works (DLW), 10 MLD at Bhagwanpur and 100 MLD at Dinapur sewage treatment plant. The remaining 53 MLD untreated sewage is directly released into the River Ganga, which leads to pollution. Present work analyzed the water samples from abovementioned three sewage treatment plants, which is being discharged into the River Ganga. BOD and DO was slightly above the permissible limit at all the sites and was maximum at the Dinapur sewage treatment plant. The sewage treatment plant at Varanasi relies mostly on primary treatment and trickling filter therefore, heavy metals were above permissible limits at all three sites. MPN index of *E.coli* was found higher indicating serious health hazard posed by intense microbial and faecal pollution. Microcosm investigation recommended integrated approach of phytoremediation of heavy metals with aquatic macrophytes and ozonization of waste water to curb the microbial pollution.

ROY, S.P., AFSAR AHMAD, M., RAJA RAMANAND, K. & VARDHAN, P., University Department of Zoology, T.M.Bhagalpur University, Bhagalpur-812007, Bihar, India. surendra0947@rediffmail.com. **Food web structure of River Ganga: a tool for detecting ecosystem responses to anthropogenic stress**

The present paper deals with the trophic interactions in the pelagic and littoral regions of the Ganga ecosystem. Food web models were developed from species lists and diet information to compare and contrast the structurally simple pelagic and structurally complex littoral habitats of the Ganga ecosystem in terms of taxonomic structure and consumers-resources relationships. Consumers comprising of zooplantonic taxa, macro-invertebrates, fish and aquatic birds were identified and their trophic interactions have been determined. It was observed that in the littoral zone of the River Ganga, a high degree of omnivory and detritus feeding appear to be general features of food webs. The food feeding habits, mode of feeding and the dimension of food items of *Daphnia carinata* (filter feeder), *Pila globosa* (grazer), *Macrobrachium rosenbergi* (filter feeder and predator), Mayfly nymphs (detritus feeder and plakton feeder), *Catla catla* (planktonic feeder), *Cirrhina mrigala* (detritus feeder) and *Wallago attu* (predator) were investigated. The food web structure operating in different zones of the River Ganga and the impact of anthropogenic stress on it has been discussed.

SHARMA, S., TACHAMO, R. D., SHAH, D.N. & NESEMANN, H., Aquatic Ecology Centre, Kathmandu University, P.O. Box No. 6250, Dhulikhel, Kavre, Nepal. ramutachamo@yahoo.com.
Assessing the saprobic water quality of Punyamata Khola, Banepa Valley by benthic macroinvertebrates

The study site extends 85˚32'10'' to 85º31'27 longitude and 27˚40'35'' to 27º36'41" latitude along the Punyamata River. It has been carried out at the stretch of 15 km and varies from 1950 m to 1449 m. The study was based on the saprobic water quality through benthic macroinvertebrates. Five sampling sites were selected along the Punyamata River, Banepa valley. Multihabitat sampling was done in all five sites. Indices like NEPBIOS ASPT, BMWP, BMWP ASPT, RBP, FBI, LQI, GRS BIOS were used to assess the biological water quality class. Insecta were identified to family level and non insecta up to *genus* and *species*. The application of different indices recorded the water quality of Punyamata Khola from I – IV at different study sites. Altogether 35 families of macroinvertebrates are recorded from whole stretch of Punyamata Khola belonging to 13 orders, 5 classes and 4 phyla. Arthropoda is the most diverse phylum comprising 80% of identified taxa. Sensitive taxa like Pomatiopsidae (*Tricula montana*) and Leptophlebiidae were dominating over other taxa in the reference site, while Tubificidae were dominating in disturbed sites. The highest diversity (20 taxa) in terms of family level was recorded in reference while lowest diversity (3 taxa) from D-3 site. The number of EPT taxa was 6 in reference, 4 in D–1, 2 in recovery site and absent in others. The GRS BIOS is concluded to be the most appropriate among the indices applied.

TAIGOR, S.R. & RAO, R.J., School of Studies in Zoology, Jiwaji University, Gwalior-474011, India. srt1979@gmail.com. **Threats on aquatic animal biodiversity of Ganges River System due to various activities: in perspective of Chambal River, Madhya Pradesh, India**

The Chambal River is an important river in the Ganges River system. The Chambal River was declared as a National Chambal Sanctuary with an aim to provide fully protected habitat for the conservation and propagation of highly endangered crocodilian species and other aquatic animals. The important aquatic biodiversity present in the Chambal River are Gharial *Gavialis gangeticus*, Mugger *Crocodylus palustris*, seven species of freshwater turtles are *Kachuga kachuga*, *K. dhongoka*, *Pangshura tentoria*, *Hardella thurgii*, *Aspideretes gangeticus*, *Lissemys punctata*, *Chitra indica*, Gangetic dolphin *Platanista gangeticus*, otter *Lutra perspicillata*, 176 species of avian fauna, 47 species of fishes and various aquatic and terrestrial vegetation. The major human activities that destroyed the habitat in the Chambal River are in the form of extensive untraditional cultivation practices on the riverbanks, overgrazing, wood collection from riverside vegetation and sand mining. Sand banks are very useful for the aquatic animals for nesting and basking. Sand mining is one of the major activities in the Chambal River. Due to sand mining, many endangered species lost their natural nesting and basking sites. Recent studies have claimed that uncontrolled sand mining operation leads to degradation of habitat, depletion of the species and habitat fragmentation. The impact of sand mining and various human activities on the aquatic animal biodiversity of Chambal River, Madhya Pradesh is discussed in this paper.

YOUSUF, A. R., BHAT, F. A., MAHDI, M. D., AHMAD, A. & JAHANGIR, A., Centre of Research for Development, The University of Kashmir, Srinagar – 100 006. aryousuf@rediffmail.com. **Limnological features of some typical water bodies of Ladakh**

Ladakh, situated in the north-eastern part of Jammu and Kashmir State, embraces the valley of the upper Indus. The river Indus has about 17% (193,762 km^2) of its catchment area in Jammu & Kashmir. No limnological reports are available on the water bodies of Ladakh including the Indus till date except for a few stray reports by Hutchinson (1933, 1936, 1937), Mir and Suri (1975) and Gopal & Zutshi (2001). Since 2003 limnology of the Indus and some of its tributaries and some lacustrine habitats of the region have been studied. In the present contribution the important features of these aquatic habitats are discussed.

The study showed that the Indus and its tributaries in the region belong to the coldwater category, with the mid summer water temperature being $<20^o$ C, water remaining frozen during winter. The water in the lotic habitats had high dissolved oxygen (8.9 – 9.3 mg l^{-1}) and low conductivity values (102 – 277 μS). The dissolved solids fluctuated significantly in different streams. In case of the lentic habitats (Lake Tso Moriri and Pangong Tso) the oxygen content was low, but the conductivity was very high. The dissolved solids showed intermediate values (403 – 623 mg l^{-1}). The concentration of nitrates, nitrite, ammonia and phosphorus was low both in the River and the lakes. The usual progression of cations was $Mg^{++}>Ca^{++}>Na^{+}>K^{+}$. Bacillariophyceae was the most dominant group of phytoplankton/ Periphyton in the lacustrine/riverine habitats, being followed by Chlorophyceae and Cyanophyceae. In the lacustrine habitats Chrysophyceae and Cryptophyceae also occurred. Planktonic invertebrates were restricted to lacustrine systems only and ten species of micro-crustacea were collected from different water bodies, *Diaptomus* spp., *Cyclops* spp. and *Chydorus ovalis* being the dominant ones. Ten species of Fishes were collected from the System. Altitude was found as one of the main factors for the distribution of fishes in the Ladakh region.

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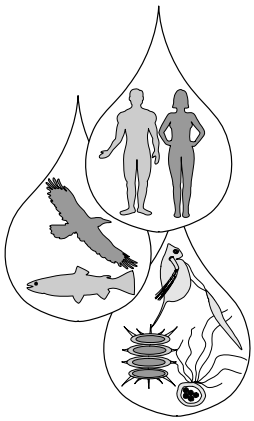

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[JOURNAL] Verduin, J., Munawar, M., 1981. Estimates of open water photosynthesis in the North American Great Lakes. Verh. Internat. Verein. Limnol. 21, 1717-1724.

[BOOK] Cairns, J., Jr., Niederlehner, B.R., Orvos, D.R. (Eds.), 1992. *Predicting Ecosystem Risk*. Princeton Scientific Publication Co., Inc., Princeton, NJ.

[CHAPTER OR SECTION IN BOOK] Dave, G., 1996. Harmonization of methods for determination of sediment and water quality in the Scandinavian countries. In: M. Munawar, G. Dave (Eds.), *Development and Progress in Sediment Quality Assessment: Rationale, Challenges, Techniques and Strategies*, pp. 213-226. SPB Academic Publishing, Amsterdam.

[REPORT] Vollenweider, R.A., 1971. Scientific fundamentals of the eutrophication of lakes and flowing waters, with particular reference to nitrogen and phosphorus as factors in eutrophication. Organization For Economic Cooperation and Development, Paris.

[ARTICLE IN FOREIGN LANGUAGE] Hildebrand, H.H., Chávez, H., Compton, H., 1964. Aportación al conocimiento de los peces del arrecife Alacranes, Yucatán (México). (Contribution to the knowledge of Alacran reef fishes, Yucatan (Mexico). In spanish). Ciencia (Mexico) 33(3), 106-135.

[CONFERENCE PROCEEDINGS] Adams, T., (Ed.) 1986. Proceedings of a Conference on xxx. 1985 Nov 3–5.: Name of publisher, New York City, New York.

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