



WWF

REPORT

IND

FOR A LIVING GANGA

Working with people and
aquatic species

FOR A LIVING GANGA

WORKING WITH
PEOPLE AND AQUATIC SPECIES

SANDEEP BEHERA
G. AREENDRAN
PARIKSHIT GAUTAM
VIVEKSHEEL SAGAR

OCTOBER , 2011



WWF-India acknowledges with thanks the support to this publication given by WWF-Netherlands under the Climate Change Impacts on Fresh Water Ecosystems in Himalayas' (CCIFEH) Project.

© WWF-India 2011

Published by WWF-India.

Any reproduction in full or part of this publication must mention the title and credit the above mentioned publisher as the copyright owner.

Report prepared by:

Dr Sandeep Behera, WWF-India

Dr G.Areendran, WWF-India

Dr Parikshit Gautam, WWF-India

Mr Viveksheel Sagar, WWF-India

Expert Review / Reviewed by:

The authors express their grateful thanks to Dr Asad R. Rahmani, Prof B.C. Choudhary and Mr Pushp K. Jain for their feedback and comments on the draft of this report.

Editors: Tapan K. Ghosh and Archana Chatterjee

WWF-India Project Research Team:

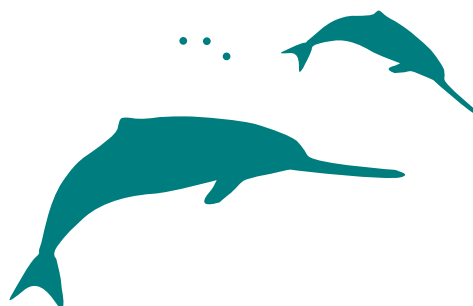
Sandeep Behera, Viveksheel Sagar, Shyam Mohan, Parmanand,

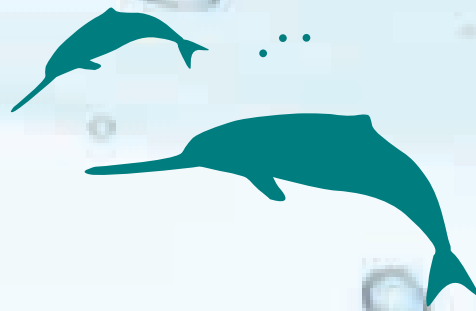
Krishna Raj and Sraboni Mazumdar

Photographs by: Dr Sandeep K Behera, WWF-India and Francois Xavier Pelletier/WWF-Canon

Designed and printed by: Adstrings Advertising Pvt. Ltd.

Citation: Behera, S., G. Areendran, P. Gautam and V. Sagar (2011), For A Living Ganga—Working with People and Aquatic Species, New Delhi: WWF-India, 84 pp.





PREFACE

WWF- India has been working in the upper Ganga river stretch since 1997. Various programmes and projects involving indicator aquatic species and local communities have been implemented. It has been a major learning experience. The overarching focus has been on the effort to improve the status of the Ganga river ecosystem.

Keeping in mind WWF-India's earlier work and achievements in upper Ganga river stretch, WWF-India's Freshwater Programme scaled up the work during 2007–2009. Along with biodiversity conservation, in this phase, WWF-India focused on adaptation strategies, like river bank restoration, alternate and improved livelihoods and reduction in pollution entering the river in this stretch of the Ganga river. The pilot sites for implementation of the project were in Karnabas and Mubarakpur villages located in Bulandsahar district of Uttar Pradesh. WWF-India used sophisticated tools and methods to understand the status of indicator species and the health of the river ecosystem.

The involvement of various partners, including religious leaders, government departments and NGOs, in the project, the improvement in the livelihood of the local people and the riverine habitat has provided additional acceptability for WWF-India's work. Awareness of the local community towards the environment has helped us greatly in motivating them to work for conservation and adaptation.

This report will also give the reader an insight of the intensive research carried out on habitat utilization of higher aquatic vertebrates such as the Ganges river dolphin and turtles in the upper Ganga river. The result of the research indicates that any such study that attempts to understand the impact of climate change on the species and the people needs a longer time frame. However, it is imperative to continue working with locally developed adaptation strategies to improve the utilization of available water resources.

ACKNOWLEDGEMENTS

We express our sincere thanks to the staff of the Uttar Pradesh Forest Department, particularly to Mr B.K.Pattnaik, PCCF & Chief Wildlife Warden and Mr Anupam Gupta, Conservator of Forest, Meerut, Mr G.K. Agrawal, DFO, Bulandsahar, Mr Satish Kumar, Ranger, Debai tehsil, along with the staff of Narora, Anupsahar, Garh, Hastinapur and J.P. Nagar, who provided invaluable support during the project work.

We also thank Dr Anmol Kumar and Dr Siddarth Kaul, from the Ministry of Environment and Forests, Government of India for their continuous support and guidance provided during the entire project duration.

The District Magistrates and Chief Development Officers of Bulandsahar, Meerut, Ghaziabad, Badaun, J.P. Nagar and Bijnor districts of Uttar Pradesh deserve special thanks for providing us the cooperation to scale up the project. We would also like to thank the Sub Divisional Magistrates and Block Development Officers of various division/blocks under the study area for providing us complete cooperation. The Gram Panchayats of all the riverbank villages we worked in extended all the help we needed; in particular, those of Farida, Mubarakpur, Puth, Karnabas, Baheria-Haridwarpur, Hastinapur and Naudevi need to be acknowledged for their continuous support during the work.

We wish to personally thank Mr Pramod Sharma, Mr Babulal, Thakhur Anand Singh, Mr Akhilesh Kumar, Mr Ashok Kumar, Mr Ram Gopal Sharma, Mr Baikunth Nath, Thakur Raghvendra Singh, Thakur Chandrabhan Singh, Mr Chunni Lal Sharma, Mr Maharaj Singh Chauhan, Mr Ganga Ram, Mr Raja Ram, Mr Bachhu Singh, Mr Harpresad Arya, Principal Irrigation Inter College, Mr Rajesh Kumar, Mr Ramswaroop, Mahamandaleswar, Dandi Ashram Karnavas, Mr Omkar Choudhary, Mr Bheem Sen, Mr Vinod Giri, Mr Dharmendra, Mr Kanchan Singh, Mr Shiv Kumar, Mr Omprakash, Mubarakpur village and late Mr Vaidya Sridutt Sharma, Farida village, for leading the community work and their support to the project team during the field work.

During the field work, several individuals helped us in many ways. Our sincere gratitude and thanks go to each and every one of them. We would particularly like to mention the following:

Mr R.P. Sharma, Ex Prof, G.B. Pant University, Mr Jitender Pandey, Mr Raja Mandal, Narora Atomic Power Station, Mr Manmohan Bharadwaj, Chairman, Narora Nagar Panchyat, Col. Raghuraj Singh and Mr J.P. Gupta for their regular expert support.

The staff of Uttar Pradesh Irrigation Department, Mr Pramod Kumar, Mr S.S. Bhaghel, Mr Rakesh Kumar are thanked for their logistic support.

Local resident and leaders, including Mr Bhagwan Sharma, Member of Legislative Assembly,

Uttar Pradesh, Mr Veer Singh Nishad, Mr Bachhan, Mr Dinesh, Mr Sanjeev Kumar, and Late Mr Hari Om Sharma, Narora, Mr Rajmohan, Mr Jagdish Prasad Sharma (Advocate), Mr Pradeep Pathak, Anoopshehar, Dr Vineet Paliwal, Mr Manish Gupta, Mr Vikas Varshney, Mr Gagan Kumar, Mr Sandeep Guru, Mr Kapil Sharma, Debai are also acknowledged for their support.

We express our sincere, whole-hearted gratitude to Mr Ravi Singh, Secretary General & CEO, and Dr Sejal Worah, Programme Director, WWF-India for providing the guidance, impetus and support required for the project. We also acknowledge our colleague Ms Archana Chatterjee, Head-Regional Programme for providing continuous support during the project.

We thank our colleagues in WWF-India's Freshwater & Wetlands Programme, Mr Murli Dhar, Dr Asghar Nawab, Ms Aditi Raina, Mr Sumit Roy, Mr Kishor Chandra, Mr Sushil Pal and Mr Trilok who extended their whole-hearted cooperation, support and inputs during the study. We also express our sincere thanks to colleagues from IGCMC, Mr Krishna Raj and Ms Sraboni Majumdar for helping us in the development of various maps.

We are thankful to Mr Shyam Mohan and Mr Parmanand, Project Officer-Narora Field Office, Mr Sanjeev Yadav, Project Officer-Hastinapur Field Office and Field Assistants Rajkumar, Kalyan, Gangasaran, Radheyshyam, Kishan Lal Sharma, Bijender, Himanshu, Charan Singh, Lakhu, Shitlu for their unrelenting hardwork, assistance and companionship during the surveys.

We express our grateful thanks to Dr Asad R. Rahmani, Director, Bombay Natural History Society, Prof B.C. Choudhary of the Wildlife Institute of India and Mr Pushp K. Jain for their feedback and comments on the draft of this report.

We are thankful to WWF-Sweden, WWF-Netherlands, WWF-UK and WWF-US for their initial support to scale up this project. We express gratitude to our international colleagues, Ms Anna Forslund, WWF-Sweden, Ms Esther Blom, WWF-Netherlands, Ms Wendy Elliott WWF-International, Mr Philip Leonard, and Ms Rebecca May, WWF-UK for the continuous encouragement and support during the course of the project.

We wish to place on record our gratitude to WWF-Netherlands, for supporting this work under the project 'Climate Change Impacts on Freshwater Ecosystems in Himalayas', and for supporting the production of this report.

AUTHORS

CONTENTS

Preface	3
Acknowledgements	4
1. Introduction	7
Part I: For A Living Ganga	
2. The River Ganga	11
3. The Aquatic Species of Concern	21
Part II: WWF-India's Conservation Initiatives	
4. Conserving Aquatic Species and Ecosystem	33
5. Conserving with Communities	51
6. Conservation Impact and achievements	64
References	69
Appendices	71





Chapter I

INTRODUCTION

The Himalayan region is considered to be the world's youngest mountain ecosystem and is aptly called the water tower of Asia. Covering over 33,000 sq kms of glaciers, it is the source of major river systems such as the Ganga, the Indus and the

Brahamaputra. The rate and magnitude of temperature rise, coupled with changes in water flow regime from run-off are key factors affected by climate change which are increasingly becoming a major global concern. The greatest impacts will be felt by large river systems like the Ganga which are fed by the flow from the glaciers precipitation and it has been predicted through earlier studies that climate change would impact glacier melt as well as precipitation levels resulting in changes in the river regime, which in turn would impact inhabiting aquatic biodiversity and river dependent livelihoods (Wong *et. al* 2007). The limited adaptive capacity of communities that directly or indirectly depend on the river system can lead to regional imbalances in economic growth and development of the subcontinent.

Water in the right quantity, quality and season is not only critical to sustain human life, but is also a key to the survival of aquatic biodiversity. The change in behavioural parameters such as migration patterns, breeding, food availability for these species will affect the biology of the river system.

There is evidence to suggest that the rate of climate change will be faster than the rate at which most species can adapt, either by migration or by changing their behaviour, physiology or form (Loarie *et. al* 2009). This can be understood only through a long-term research study. However, a short-term goal for management is to ensure the survival of species in spite of additional threats resulting from climate change. A first step towards this is to identify threat processes and threatened species or communities.

WWF-India had these considerations in mind when it began work in the upper Ganga river in 1997. The Upper Ganga (UG) stretches from Rishikesh to Narora, is approximately 300 kms long and passes through the states of Uttarakhand and Uttar Pradesh. From the late nineties, WWF-India has been working closely with river bank communities and aquatic species that could serve as a reliable indicator of the health of the Ganga river. While different strategies have been adopted from time to time, the focus has always remained on people and species; the goal being to reduce the huge burden

of pollution and other anthropogenic pressures that Ganga river has borne, particularly in the last few decades.

The two species that have been the focus for WWF-India are the Ganges river dolphin and the freshwater riverine turtles. The Ganges river dolphin is an aquatic mammal placed at the apex of the aquatic food chain. The river dolphin is extremely sensitive to changes in water regime and it can be reasonably assumed that this results in changes in their breeding and migratory behaviour. Since turtles use riverbanks as their basking and nesting sites, their survival and procreation is also greatly affected by changes in the river flow regime.

The sections that follow attempt to encapsulate WWF-India's rich experience of working with people and species in the upper Ganga since the late nineties. It particularly highlights WWF-India's work during the phase 2007–2009 when climate change concerns were also taken up and sought to be addressed.

Part I

FOR A LIVING GANGA



INDIA



(Many Also in English)



Chapter II

THE RIVER GANGA

The Ganga originates at 4,000 meters above sea level in Gangotri, Uttarkashi District, Uttarakhand, India from the southern slopes of the Himalayan range. It flows through five states

in India—Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal, covering a distance of 2,510 km before it enters the Bay of Bengal. During its long course it embraces many large rivers, small torrents and tributaries of varied origin (Behera 1995, Rao 1995).

In Uttarakhand, the river after passing through Rishikesh, enters Haridwar which is situated on the right bank of the river. The river then makes a sweep towards the south-east, maintaining the same direction for several kilometres beyond the Balawali railway bridge. After crossing Bijnor district the river enters Meerut, Ghaziabad, Bulandsahar, Jyotiba Phule Nagar and Moradabad districts, which are situated on the right and left banks of the river respectively. Brijghat is a religious *ghat* (river banks utilized for bathing and rituals) situated on the right bank. The river flows about 82 kms to reach Narora. Thereon it continues southward covering 200 kms through



Human activity at Brij Ghat



Brij Ghat

Kachlaghat and reaches Ghatia Ghat at Farrukhabad. From Farrukhabad the river reaches Kanpur after covering a distance of 160 kms and then moves south-east to reach Allahabad.

In between Rishikesh and Allahabad, the major northern tributaries which join the Ganga are Bia River (Kalagarh feeder canal), Ramganga and Gomti rivers, whereas the southern tributaries are Kali and Yamuna.



Religious Ghat, Narora



Narora Barrage

The natural flow of the Ganga river has been obstructed over the years by the construction of barrages in the upstream. These barrages have been constructed either for power generation or for irrigation. A series of barrages (refer to map pp. 28–29) have been constructed at

Rishikesh, Haridwar, Bijnor Narora and Kanpur. Among them, the barrage at Rishikesh was specially constructed to supply water to the Chilla Power Station. The river water at Narora was diverted both for irrigation (Lower Ganga Canal) and for the Atomic Power Plant located at Narora. The other three barrages at Haridwar, Bijnor and Kanpur (Bithoor) are meant for irrigation through the Upper Ganga Canal, Madhya Ganga Canal, and Kanpur Canal, respectively.

Several well known tributaries such as the Kosi, Son, Gandak and Ghaghra join the Ganga which forms a formidable current in the stretch between Allahabad in Uttar Pradesh and Malda in West Bengal. On its long meandering journey it passes the towns of Mirzapur, Varanasi, Patna and Bhagalpur.



An idol of River Ganga

At Bhagalpur, the river moves past the Rajmahal Hills, and turns south. At Pakur, the river begins its attrition with the branching away of its first distributary, the Bhagirathi-Hooghly, which goes on to form the Hooghly river. Near the border with Bangladesh, the Farakka Barrage built in 1974 controls the flow of the Ganga, diverting some of the water into a feeder canal linking the Hooghly to keep it relatively silt free.

After entering Bangladesh, the main branch of the Ganga (refer to map pp. 28–29) is known as the Padma river until it is joined by the Jamuna river the largest distributary of the Brahmaputra. Further downstream, the Ganga is fed by the Meghna river, the second largest tributary of the Brahmaputra, and takes on the name of 'Meghna' as it enters the Meghna estuary. Fanning out into the 350 km wide Ganga Delta, it finally empties into the Bay of Bengal. Only two rivers, the Amazon and the Congo, have a greater discharge than the combined flow of the Ganga, the Brahmaputra and the Meghna river system.

The Ganga and its tributaries drain a large—about one million square kilometres—and fertile basin that supports one of the world's highest human population densities. It should be noted that almost half of the population of India lives on one-third of the landscape within 500 km of the Himalayan range, along the Gangetic plains (Mishra 2010).



Human Habitation

The Ganga basin is one of the most populous regions on Earth. It is home to 450 million people with an average density of over 550 individuals per square kilometre. In the delta zone this rises to over 900 per square kilometre. As a result, there is strong demand and competition for natural resources, especially water for domestic use and irrigation, and most of the basin tributaries are regulated by barrages. Fisheries along the river are of considerable economic value and their output makes a major contribution to regional nutritional needs.

There are some 30 cities, 70 towns and thousands of villages along the banks of the Ganga. Nearly all of the sewage from these population centres—over 1.3 billion litres per day—passes directly into the river (WWF 2003), along with thousands of animal carcasses, mainly of cattle. A large number of



Agricultural activity at sand island, Rajghat



Livelihood from a Ganga river island

Pollution from Simbhaboli
Sugar Mill drain joining Ganga
at Puth village



factories/industries like sugar, chemicals, fertilizers, small-scale engineering, pulp, cotton and tanneries are situated on the banks of the river. The discharges from these industries enter the Ganga river directly or indirectly and pollute the river to a considerable extent. An estimated 260 million litres of industrial wastewater, largely untreated, is discharged by hundreds of factories, while other major pollution inputs include runoff from the

Fishermen at
Anupsahar





Pollution from religious activities, Anupsahar

agricultural fields. More than 6 million tonnes of chemical fertilizers and 9,000 tonnes of pesticides are used annually within the basin (Wong *et al* 2007).

The Ganga river also has religious and mythological significance. All along the Ganga, most of the ghats have religious importance. Pilgrims in large numbers, often in thousands, take a holy bath, cremate their dead and perform other post-cremation activities on the banks of the river and thus contribute to the pollution of the river. Over the past three decades or so, the pollution of the Ganga has reached serious levels leading to local and national campaigns and actions to restore the health of the sacred river (Behera 1995; Sinha *et al* 2000).



Air pollution from a brick kiln

Flora and Fauna of the Gangetic Plains

The Ganga supports a rich fauna and flora, including the endangered Ganges river dolphin (*Platanista gangetica gangetica*) and at least nine other species of aquatic mammals. Reptiles include three species of crocodiles along with one species of monitor lizard (*Varanus bengalensis*) and eleven species of freshwater turtles. The Ganga also has the richest freshwater fish fauna (378 species) anywhere in India (Behera 2002; Rao 1995).



Sarus cranes at Narora

The riparian zone supports many plant species that are of both ecological and economic importance. Most plants play an important role in nutrient and water conservation and in controlling soil erosion. They also possess, in many cases, important medicinal properties.

Where the river meets the Bay of Bengal, the famed Sundarbans mangroves form the world's largest mangrove ecoregion, covering an area of 20,400 sq km in a chain of 54 islands. They derive their name from the predominant



Indian Skimmer

mangrove species, *Heritiera fomes*, which are known locally as *sundari*. Animals in the delta include the endangered Royal Bengal Tiger (*Panthera tigris tigris*), the Indian Python (*Python molurus*), and crocodile (*Crocodylus porosus*). Two species of dolphins are found in the delta: the Irrawaddy Dolphin (*Orcaella brevirostris*), and the Ganges river dolphin (*Platanista gangetica gangetica*).



Tree plantation by WWF-India on the river bank at Karnabas

The Irrawaddy dolphin is not a true river dolphin, but enters the delta from the Bay of Bengal. The Ganges river dolphin is a true river dolphin and is extremely rare and thus considered 'endangered' by the IUCN (Sinha 1993; Behera 1995). The Ganges river dolphin is important not only because it is endangered, but perhaps more so because it is a reliable indicator of the health of the Ganga, in fact the whole Ganga river ecosystem. This is why the Government of India declared it as the 'National Aquatic Animal' in 2009.

The Ganges river dolphin has received protection in nine protected areas (PAs) in India. Out of these nine, only one protected area 'Vikramshila Ganges



National Chambal Sanctuary, a good river dolphin habitat



Turtles (*Pangshura smithii*) basking in the sun

River Dolphin Sanctuary' near Bhagalpur is specially notified for the Ganges river dolphin. Dolphins have also received some protection in the National Chambal Sanctuary, specially created on the Chambal River, a major tributary in the Ganga river system, for the protection of the Indian Gharial (*Gavialis gangeticus*).



A scientist holds a newborn turtle



Chapter III

THE AQUATIC SPECIES OF CONCERN

There are several riverine species which are threatened by human activities in the Ganga basin. However, the Ganges river dolphin and the riverine turtles are two reliable indicator species of the health of the Ganga river ecosystem. This makes them species of special concern for WWF-India.

An indicator species is an organism that, by its presence in a biotope, denotes particular characteristics of that environment that would otherwise be difficult to determine (Rao 1995). Studying indicator species could create the basis for a sustained research programme to see how the changes in the numbers of the said species can be related to the health of the river system. The health of the river Ganga can be substantially assessed by studying the indicator species in the river. This would help to implement various programmes for restoration of the river system.

The Ganges river dolphin

River dolphins swim in some of the world's mightiest rivers, including the Ganges, Indus, Yangtze and Amazon. These river basins are also home to over 15 per cent of the world's population and include some of the most densely populated and poorest areas in the world. Human perturbations and anthropogenic disturbances have led to drastic declines in dolphin populations over much of their distribution range during the last several decades. Several Asian species are now amongst the most endangered of all mammals. The Yangtze river dolphin (*Lipotes vexillifer*), was declared functionally extinct in 2006 (Bashir *et al* 2007).

Historically, Indians have known about this splendid creature since time immemorial, but it was officially and scientifically discovered by Roxburgh

in 1801. The animal abounds in our ancient literature and was also mentioned as '*Khuk-abi*' in *Babarnama* during the Mughal period, when the rural folk used to burn dolphin oil for lighting their homes. However, it was John Anderson who first published a scientific report on the dolphin in 1879 after



Ganges River Dolphin (*Platanista gangetica gangetica*)

which there was no scientific information available on this species for the next one hundred years (Behera 1995).

Research studies under the Ganga Action Plan project in the 1980s provided the baseline information about the species population and distribution. It was estimated at the time that around 5,000–6,000 dolphins were present in its distribution range and distributed in the Ganga-Brahmaputra-Meghna and Karnaphuli river systems and its tributaries of Nepal, India, Bhutan and Bangladesh, between the foothills of the Himalayas and the tidal zones. In India, one can sight these beautiful dolphins along deep river reaches in Assam, Bihar, Jharkhand, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal.

While there is no complete scientific estimate of range-wise abundance of the species, it is assumed that presently around 2,500 individuals are surviving across their entire range, out of which an estimated 1,800 are within Indian territory. The population is declining fast. It has already become extinct from most of its earlier distribution ranges and even in its present day distribution ranges the density of this animal is decreasing.

Conservation Status

On paper, the conservation status accorded to the Ganges river dolphin appears to be impressive. The Ganges river dolphin is listed in Appendix 1 of CITES. Further, the IUCN World Conservation Union has classified the Ganges river dolphin as 'Endangered'. The UN Convention on the Conservation of Migratory Species of Wild Animals (CMS), known as the Bonn Convention, which focuses on wild animals crossing national boundaries, has included the Ganges river dolphin in Appendix I. India has also included the species in Schedule 1 of the Wildlife (Protection) Act, 1972. In 1991, the Government of India notified a stretch of 150 kms (middle Ganga) between Kahalgaon to Bhagalpur as a Dolphin Sanctuary.



Indus river dolphin (*Platanista gangetica minor*)

In 2005, another 82 km of stretch (Upper Ganga) from Brijghat to Narora was declared as a Ramsar Site, especially for the conservation of dolphins. Subsequently in 2009, the Indian Government accorded the status of 'National Aquatic Animal' to the Ganges river dolphin.

Importance of the species

Just like the tiger in a forest ecosystem, the Ganges river dolphin is an indicator species for the river ecosystem. It is at the apex of the food chain. It is an endemic and rare charismatic mega-fauna found only in the Indian subcontinent. At the same time it is a part of our natural aquatic heritage.

Distribution of the species

The Ganges river dolphin
(*Platanista gangetica gangetica*)

and Indus river dolphin (*Platanista gangetica minor*) are the two sub-species of freshwater dolphins found in Bangladesh, India, Nepal and Pakistan. The Ganges river dolphin is primarily found in the Ganges and Brahmaputra rivers and their tributaries in India, Bangladesh and Nepal, while the Indus river dolphin is found in the Indus river in Pakistan and its tributaries, Beas and Sutlej, in India. From the 1970s until 1998, they were regarded as separate species; however, in 1998, their classification was changed from two separate species to subspecies of a single species (Smith and Braulik 2008).

The habitat of the Ganges river dolphin is within one of the most densely populated areas of the world. The biotic resources in the dolphin habitat are under severe threat from over-exploitation by the communities who live close by as well as due to various developmental projects. According to a study by S. Jones (1982) 'anything can happen under heavy population pressure and the desperate conditions brought about by unexpected natural calamities or man made disasters. There is no guarantee that the Ganga river will be left in peace.' With the increased utilization of water resources for various development projects, the water quantity as also quality in the Ganga river has deteriorated considerably, thereby affecting the aquatic environment.

The population of the Ganges river dolphin has declined throughout its former range due to habitat destruction, commercial exploitation and incidental catch in fishing nets. The Ganges river dolphin is still hunted for meat and oil, both used medicinally. The oil is also used to attract catfish in net fishery (Sinha and Sharma 2003). Dams and barrages have created permanent barriers across the rivers blocking the movement of the Ganges river dolphin leading to isolated populations. According to a study in the late eighties (Mohan 1989), the Ganges river dolphin trapped above the dam were exposed to poaching, especially during summer months.

The study also suggests that the dolphins below the dams are threatened by heavy pollution, increased fishing activities and vessel traffic. Due to all these human interventions, dolphins in the upper reaches of Ganga river were considered extinct. In the 1991 publication by the Ganga Project Directorate, Government of India (Murthi *et al* 1991) there is no mention of the Ganges river dolphin in the upper reaches of Ganga river.

Habitat preference

Obviously the number, distribution and size structure of aquatic animals such as river dolphins and turtles in various water bodies indicates that some specific parameters will characterize the suitable habitat. The habitat is the most essential component in the life cycle of an organism. For impact assessment and habitat management of a species, detailed information on the habitat is absolutely necessary.

Although the Ganges river dolphin lives in freshwater, it is sometimes also found in brackish water. However, it never enters the sea. It is generally assumed that salinity defines the downstream limits of its distribution, while rapids rocky barriers in high elevation areas define the upstream limits. These dolphins are abundant in the long stretches of deep water in association with shallow water and meanderings, confluences and mid-channel sand bars (Smith and Reeves 2000).

Primary habitats of the dolphins are characterized by an eddy counter current system in the main river flow caused by a point bar formed from sediments deposits, a convergent stream branch or by an upstream meander. The Ganges river dolphin is also found below sand bars and bridges where eddies are formed (Sinha and Sharma 2003).



Testing the water quality dolphin habitat

Interestingly, the Ganges river dolphin adapts to a wide range of temperature fluctuation. This it does by moving into deeper pools to maintain its body temperature. It can tolerate temperature as low as 5°C in the River Karnali in the winter season in Nepal, and as high as 35°C in the summer season in the plains of Uttar Pradesh and Bihar. It is found in highly turbid waters during monsoon, even less than 20 cms. in depth. Thus, water temperature and turbidity appear to be factors of low significance as compared to depth, in determining the distribution of this species (Behera 1995).

Pressures and Threats

Ganges river dolphins were once found in good numbers in perennial rivers with continuous or scattered deep pools. The perennial Himalayan-fed rivers supported dolphin habitats. Degradation of the catchment areas due to deforestation not only reduced the flow, but also brought huge quantities of silt, which filled up the available deep pools. This considerably reduced the habitable stretch of the river and the dolphins were pushed into those areas where, unfortunately, human activities also impinged. This may be the reason for the depletion of the dolphin population over the past few years.



Water extraction from Ganga for agriculture

The Ganges river dolphin will face extinction in this century unless present trends are reversed. In some areas direct exploitation takes place side-by-side with degradation of habitats due to anthropogenic pressures combined with development processes. The Ganges river dolphin is largely distributed where human population growth is also the highest, and environmental conservation is a lower priority as there are other pressing developmental needs. This problem is exacerbated by the fact that riverine habitats are highly vulnerable to degradation (see Appendix II for threat zones identified in the study area).



Soil erosion at Puth village, Ghaziabad

Human Activities

The Ganga is heavily polluted with 9000 tones of pesticides and 6 million tonnes of fertilizers used in the vicinity of the river each year (Wong *et. al* 2007). This is ecologically harmful to the Ganges river dolphin population. Pollution by persistent chemicals is potentially harmful to the higher trophic animals in the food chain. The Ganges river dolphin is a top predator and is therefore sensitive to environmental perturbations. Although the stretch in question has a relatively low direct discharge of industrial pollutants, there is a constant threat of pollution by a number of industries which discharge heavy loads of pollutants into the tributaries that join the Ganga river.

In most of the areas, the riverbanks are used for agricultural purposes and these agricultural activities along the riverbank, pose a threat for dolphins. Due to agricultural run-off, chemicals such as DDT, Aldrin and Dieldrin are leaching into the river. Pollutants entering into the dolphin habitats are harmful to the dolphin both directly and indirectly. The pollutants in the river are also lethal to many organisms like zooplanktons, crustaceans, snails and fishes, which are a part of the food chain of dolphins.

Habitat degradation has led to a decline in the Ganges river dolphin population. The increasing human habitations and industrialization in the catchments areas have had an adverse impact on the species' habitat. Riverine habitats are highly vulnerable and the degradation of the river ecosystem can be attributed to several human activities other than hunting and fishing. Construction of dams and barrages on the Ganges and the rivers of Nepal and many of their tributaries has fragmented the dolphin population. Some of these isolated populations have disappeared, perhaps because of disruption of their food supplies. At Kapti dam on the Karnaphuli river, the dolphin population present above the dam earlier has practically



Pollution from religious activities, Anupsahar



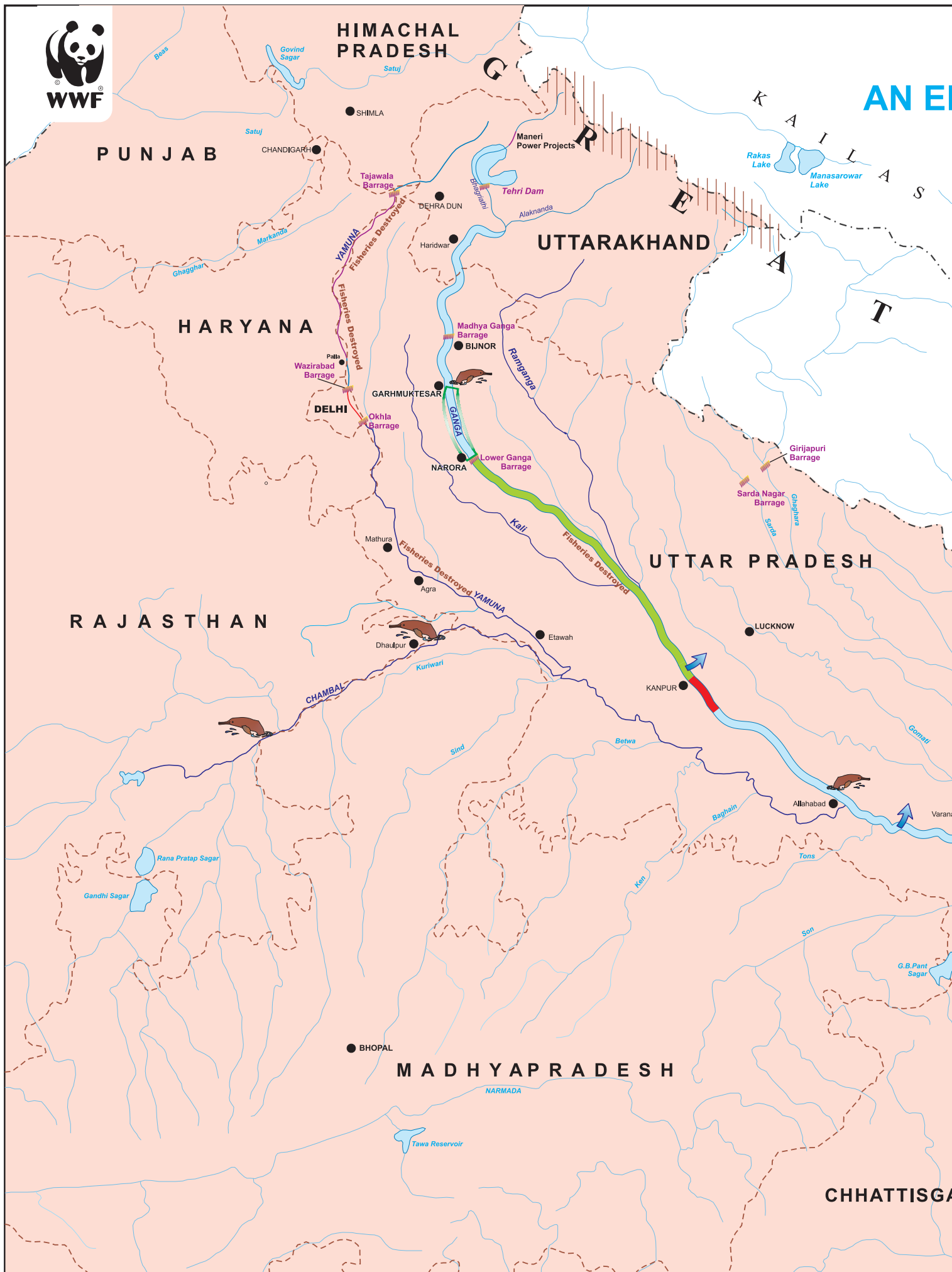
Fishing activities

disappeared and the population below the dam is declining. The barrages on the Ganga river at Bijnor and Narora have also had an adverse impact on the river dolphin habitat. Although fragmented populations may survive in the short to medium term, altered processes contribute to their demise in the long term (Behera 1995).

Freshwater Turtles in the Ganga

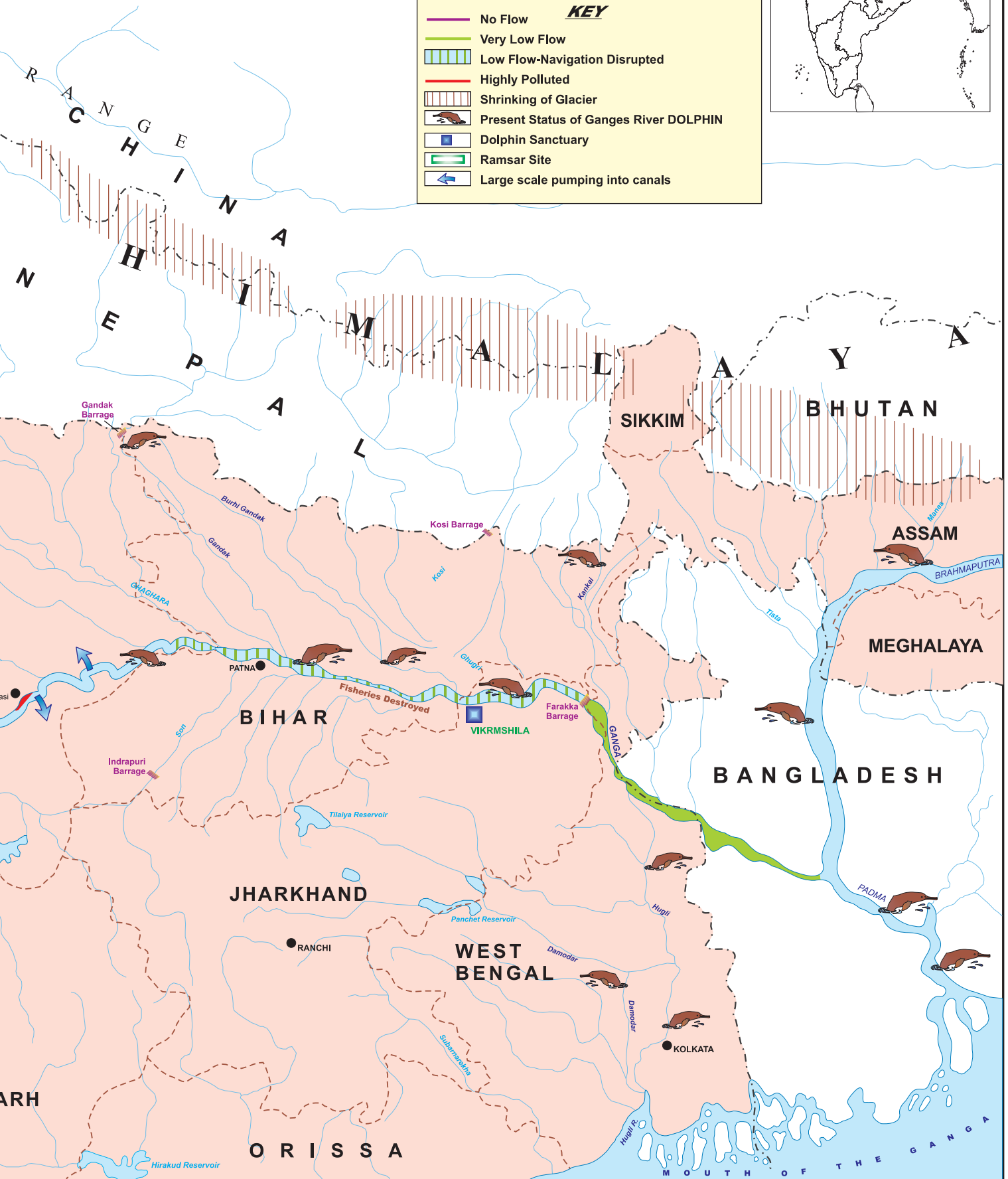
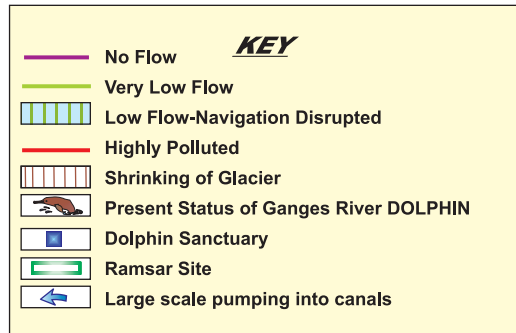
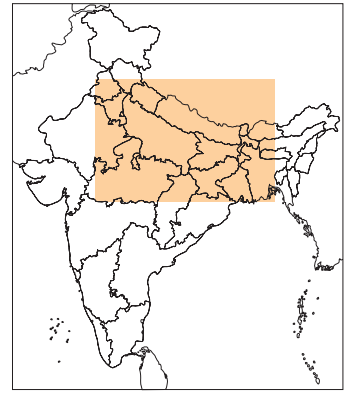
Water resources support rich faunal diversity, including various species of reptiles. Among them, freshwater turtles inhabit different water bodies ranging from shallow ponds, deep lakes, and rivers (Rao and Singh 1986). Many of the species have a wide distribution throughout the Ganga river system.

In India, turtles play a very important role as religious symbols, both in folklore and culture. The turtle, according to Hindu mythology played a key role in a story about the churning of the Cosmic Ocean. At the suggestion of Vishnu, the Gods (*Devas*) and demons (*Asuras*) churned the primeval ocean in order to obtain Amrita-the nectar, which will guarantee them immortality. To churn the ocean they used the Serpent King, Vasuki, as a churning-string and Mount Mandara as the churning pole. However, once the mountain was placed in the ocean, it began to sink. Vishnu in his second incarnation, in the form of a turtle, Kurma, quickly came to their rescue and supported the mountain on his back., which helped in creating the nectar of immortality and in the victory of good over evil. Turtles and tortoises can be found in temple ponds, tanks and enclosures where devotees feed them.



GANGA BASIN

ENDANGERED FRESH WATER ECO REGION



With 28 species of tortoises and freshwater turtles, India has one of the most diverse chelonian fauna in the world. It ranks among the top five Asian countries in terms of its importance for turtle conservation. Unfortunately, nearly 40 per cent (11 of 28 taxa) are listed as either Endangered or Critically Endangered on the IUCN Red List. With nearly a billion people living in India, the aquatic habitats, as well as the turtles that inhabit them, face a growing number of threats that will, in all likelihood, increase. Multiple threats take their toll, but uncontrolled and non-sustainable commercial exploitation by man has been the single-most damaging factor.

Freshwater turtles in the Ganga are divided broadly into two categories: Hard-shell turtles (Emydid turtles) and Soft-shell turtles (Trionychid turtles). A few studies conducted on Indian freshwater turtles have mainly dealt with taxonomy and their broad distribution ranges (Smith 1933; Pritchard 1979; Daniel 1983; Tikader and Sharma 1985).

The lack of scientific information on the biology, ecology and population status of turtles is considered as one of the serious hurdles to devising management strategies for turtles in the Ganga. In addition, a large number of turtles are slaughtered in different parts of the basin for consumption. Due to lack of restriction on the capture of turtles and little or no enforcement of existing legislation, populations of turtles in different water bodies is decreasing (Moll 1984). The national as well as international scientific and conservation communities have therefore declared a number of turtle species as endangered in Schedules I of Indian Wildlife (Protection) Act, 1972 and in Red Data Book, IUCN 1982 (Rao 1990).

The Government of India, recognizing the need to increase the population of different species of turtles, initiated a turtle rehabilitation project in the 1980s. This project focused on hatching and releasing of young turtles at different sites in the Ganga river (Basu 1987). Although the project was successful initially, the scientific understanding of the biology, ecology and population status of the turtles for proper implementation of further management programmes is still lacking. Therefore, there is a need for research studies on turtles in the Ganga river to identify species diversity, distribution patterns and habitat preferences. In addition, it is necessary to evaluate the water quality in the Ganga river and its suitability for the survival of different species of freshwater turtles which act as indicator species.

PART II

WWF-INDIA'S CONSERVATION INITIATIVES





Chapter IV

CONSERVING AQUATIC SPECIES AND ECOSYSTEMS

WWF-India initiated a conservation programme for the Ganges river dolphin in 1997. This began with a series of surveys and field visits to specific stretches and to surrounding villages in some of the well-known habitats of the dolphin.

WWF-India helped set up the Dolphin Conservation Action Group in collaboration with the Asian River Dolphin Committee

and initiated several projects for the conservation of the river dolphin in its distribution range. The WWF-India team decided to concentrate its comprehensive work in the upper Ganga river, in the stretch between Bijnor and Narora in Uttar Pradesh, India. The total length of the stretch is 165 kms. This stretch has its own importance as it is the uppermost distribution range of the species in the Ganges river, and the dolphins in this stretch are trapped in between two barrages (upstream at Bijnor and downstream at Narora). WWF-India has regularly monitored this stretch in a bid to get a holistic understanding of Ganges river dolphin's behaviour.

In 1997, WWF-India's main aim was to develop a strategy for tackling threats to one of the most ecologically valuable stretches of the whole Ganga system, known to support one of the highest-remaining densities of the Ganges river dolphin—an indicator of the relatively good health of the ecosystem in this location. Adequate research on the species and the ecosystem had not been done at that time.

The strategy adopted by WWF-India demonstrated a species-led approach to river conservation with a strong focus on working at a local level and using the cultural and religious importance of the river as a means of

Consultation with the villagers at Karnabas

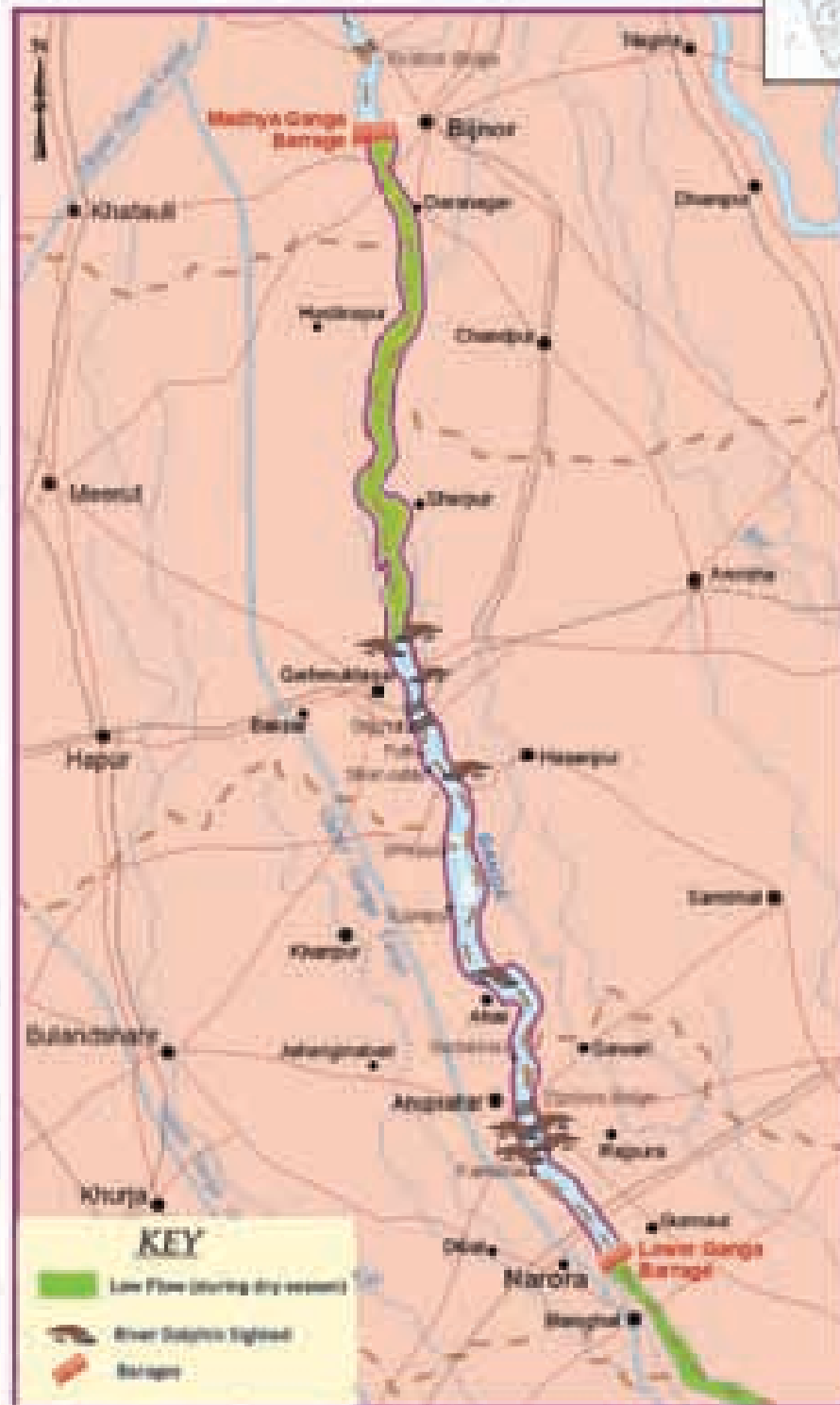
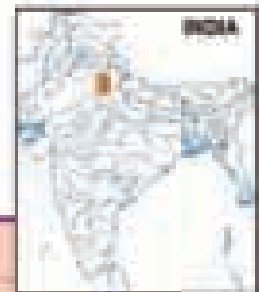


engaging with rural communities. Although covering just a small section of the river, the project demonstrated the potential for applying similar approaches at a much wider scale to promote a locally based 'stewardship' ethos. WWF-India benefitted from its earlier experiences of working with species and communities when it took up the project phase 2007–2009.

UPPER GANGA RIVER

Bijnor to Narora (165 Km)

In the State of Uttar Pradesh



© 1999 Blackwell Science Ltd *Journal of Internal Medicine* 245: 399–406

1000

In this phase, apart from study of the indicator species to understand the health of the Ganga, work was undertaken to improve the capacity of local communities to adapt to change in environmental conditions.

Some of the main features and activities of this phase can be highlighted as below:

1. Mapping of the existing land use land cover of the region with a focus on river basin.
2. Highlighting the threats to the Indicator Aquatic species population with special emphasis on Ganges dolphin and turtles in the study area.
3. Mapping of aquatic biodiversity based on the ground information and GPS locations.
4. Studying land use patterns in and around the river basin.
5. Identifying and prioritizing areas which require immediate protection and management intervention in terms of Indicator Aquatic species population and river threats.
6. Detailed mapping of two focal villages where, conservation/climate change adaptation efforts were taken up.

Understanding the Ganges river dolphin Habitat in upper Ganga river

The upper Ganga river (UGR) is situated between 78° 24' E to 78° 69' E longitude and 28° 6' to 30° 4' N latitude. The area covers a region from the Himalayan foothills to the Gangetic plain. This region also exhibits mixed land cover patterns. The UGR starts from an undulating high altitude zone and flows towards the low altitude or plain zone.

The analysis was taken up within a 10 km buffer area along the path of River Ganga flowing between Bijnor and Narora in the state of Uttar Pradesh (refer to Map-1 & Map-2 , Appendix III).

The study area has rich biodiversity. The presence of river dolphins along with around a hundred species of wetland birds, twelve species of fresh water turtles and two species of crocodiles was recorded. Based on its rich avifauna, Birdlife International and the Bombay Natural History Society had declared this area as an Important Bird Area (Islam and Rahmani 2004). Further, an 82 km stretch of the UGR from Brij Ghat to Narora was declared as a Ramsar Site in the year 2005 due to its high biodiversity value.

The study was conducted to understand the present status of the dolphin population in this stretch and to suggest special measures for habitat conservation. The study indicates that dolphins were restricted between Brijghat and Narora barrages (a stretch of approximately 82 kms) during the dry season as the water availability upstream of Tighri Ghat is very low. Upstream of Brijghat, the Ramganga feeder canal, originating from Kalagarh barrage on Ramganga river, feeds the main Ganga at Tigrighat. Due to the good water availability at this place the habitat is highly suitable for the dolphin. Insufficiency of water is one of the factors for restricted distribution of dolphins.

Interviews with local communities revealed the occurrence of dolphins at Balawali, 50 km downstream of Haridwar in the past (i.e., before the construction of Bijnor barrage). During the monsoon, dolphins were sighted up to Bijnor barrage, which is the uppermost range of dispersal. The migration is blocked further upstream due to the barricading of the Bijnor barrage. During the entire study period no dolphins were sighted upstream of Bijnor barrage.

It is observed that the Ganges river dolphin avoids the turbulence and noise of the barrage gate during monsoon and stays away from the barrage. However, when the gates are totally open and there is no turbulence or noise, the dolphins move downstream of the barrages.

Sightings of Ganges river dolphin in many pockets between Bijnor and Narora indicate a patchy distribution of dolphins in this stretch. The deep pools and presence of food have compelled dolphins to restrict themselves to these pockets.

Survey results earlier in 1993–95 had shown an estimated population of 22 dolphins in the same study area. However, the WWF-India study from 1997–2006 indicated that there was an increase in the population up to 40. Subsequent studies in the area from 2007 onwards showed a further increase in the dolphin population. This aspect will be discussed in greater detail in a later section.

Habitat Utilization During the year 2007, WWF-India, building on its earlier work in the upper reaches of Ganga river, initiated a major programme for biodiversity monitoring between Bijnor and Narora stretch of the river with the use of geospatial technology and also for raising community support for conservation of the river system.

STUDY OF RIVER FLOW REGIME

The flow regime is regarded by many aquatic ecologists to be the key driver of river and floodplain wetland ecosystems. There are four key principles to highlight the important mechanisms that link hydrology and aquatic biodiversity and to illustrate the consequent impacts of altered flow regimes:

- Flow is a major determinant of physical habitat in river system, which in turn is a major determinant of biotic composition;
- Aquatic species have evolved life history strategies primarily in direct response to the natural flow regimes;
- Maintenance of natural patterns of longitudinal and lateral connectivity is essential to the viability of populations of many riverine species;
- The invasion and success of exotic and introduced species in rivers is facilitated by the alteration of flow regimes.

The impacts of flow change are manifest across broad taxonomic groups including riverine plants, invertebrates, and vertebrates. Despite growing recognition of these relationships, ecologists still struggle to predict and quantify biotic responses to altered flow regimes. One obvious difficulty is the ability to distinguish the direct effects of modified flow regimes from impacts associated with land-use change that often accompanies water resource development. Currently, evidence about how rivers function in relation to flow regime and the flows that aquatic organisms need exists largely as a series of untested hypotheses.

Responses of rivers and river ecosystems to dams are complex and varied, as they depend on local sediment supplies, geomorphic constraints, climate, dam structure and operation, and key attributes of the biota. Therefore, uniform prescriptions cannot substitute for local knowledge in developing prescriptions for dam structure and operation to protect local biodiversity. One general principle is self-evident: biodiversity is best protected in rivers where physical regimes are the most natural. A sufficiently natural regime of flow variation is particularly crucial for river biota and food webs (Bunn and Arthington 2002).

The core focus of this project was to find out the habitat utilization of two indicator species: the Ganges river dolphin and freshwater turtles in the upper reach of the Ganga river (Bijnor to Narora). The main idea was to see how far the status of the indicator species could be correlated to the health of the river ecosystem. This project also aimed to assess the impact of climate change on the habitat of these species, if any, and demonstrate the impacts and adaptability of these indicator species and the local community.

Methodology

Research was conducted on the habitat utilization of the indicator species (Ganges river dolphin and selected species of freshwater turtles) to illustrate the ecological importance of alternating periods of low and high flow as well as change in river hydrology (path and depth of river water, current velocity, wetted perimeter and substrate type) in the upper Ganga river (Behera, Sagar & Nawab 2008).

Monitoring & Enumeration

During the study conducted between January 2007 and November 2009, the stretch of the upper Ganga river (Bijnor to Narora) was categorized into various zones on the basis of hydrological and habitat characteristics.



Research study

To help find out the location of the Ganges river dolphin, an instrument named sonar depth finder (Garmin GPSMAP 178/178C Sounder) was used. By using this instrument, monthly sighting locations were monitored. This sonar depth meter data was integrated with the Geographical Information System (GIS) to plot the location of the dolphin. Monthly maps of these sighting locations were prepared.

A 12-hour schedule was followed from 0600 hrs to 1800 hrs with mid-break of 3 hrs. Nights were spent in the boat anchored near the river island. For a systematic survey, boat transect survey was done by an inflatable boat with 30 hp engine with constant speed 6 km/h. During this survey, the river stretch was also divided into individual transacts of 5 kms to monitor the dolphins.

Whenever dolphins were sighted, the site of surfacing was approached and the following data was collected: sighting time, angle from the boat, group size, depth of the river, river velocity, water temperature, dissolved oxygen and conductivity at the spot. When the dolphins were sighted, their numbers were determined by the following criteria:

- Number of dolphins surfacing simultaneously;
- Number of dolphins surfacing within an interval of 5 seconds at a distance of more than 10–20m from each other;
- Size of the dolphin.

A dolphin measuring below 1 m was considered a calf, 1 to 1.75 m as adolescent and more than 1.75 m as an adult. No attempt was made to segregate male and female in the field.

During the study, selected water quality parameters were collected to mark the habitat utilization of the species. Parameters such as velocity, depth, temperature, pH, conductivity along with DO, chloride, silicate, calcium, fluoride, iron, chlorine and ammonium were recorded.

With the help of satellite data and ancillary data, it was observed that the path of river Ganga had changed significantly from the 1970s to 1997. A small deviation was also observed during the period 1997 to 2007. Satellite data of 1997 and ancillary data show maximum path difference of 4.6 km and minimum 0.8 km approximately. The change in the path of the river has resulted in siltation thus reducing the water depth. Identified areas were plotted on a map (refer to Map 3, Appendix III).

Data Used

Survey of India toposheets of 1:50,000 scale were used for generation of base layers. In addition IRS-P6 LISS III satellite imageries with spatial resolution of 23.5 m for 1997 and 2007 were used for extracting land use/land cover of the Area of Concern (AOC).

The land use data was used for change analysis purpose (refer to Map 2, Appendix III).

Findings

During the dry season, the population of the Ganges river dolphin showed equal distribution all along the study area. As the level of water recedes, the dolphin groups stay in the region having deeper pools. Certain river stretches in-between have water level less than 1 m, which the dolphins cannot cross. Therefore the population moves towards the watery channels present in the vicinity and remain there till the monsoon. As the water level rises with the onset of monsoon, the population dispersion increases due to availability of water in the entire region.

Most of the individuals were recorded in the deeper sections of the river stretch. The deeper the area the more strata it has, and hence, the availability of food in such areas is usually high. Although in moving water the stratification is lower, when moving water mixes with standing water it forms eddy counter currents, which is an ideal habitat for the Ganges river dolphin due to greater fish availability.

The water velocity has an impact, both direct and indirect, on the living organisms found in the aquatic habitat. During the study a maximum water velocity of 6.56 m/sec (during rainy season) was recorded in the dolphin habitat. It is also observed that dolphins do not prefer very fast flowing water.

Water depth has a positive influence on the Ganges river dolphin. Deep water is usually preferred by the dolphins due to availability of temperature gradient and food present in

Field team measuring the river flow in the Ganga



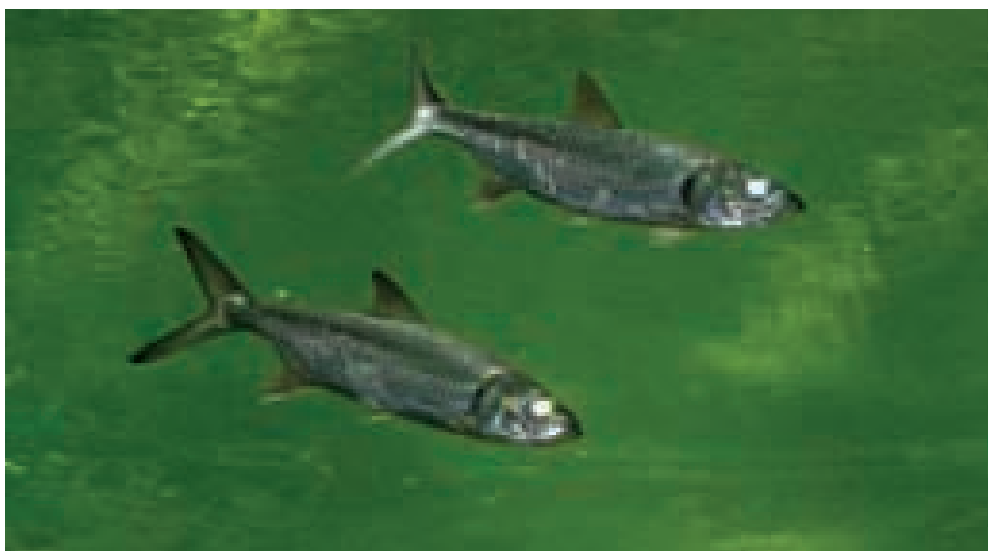
different trophic levels of the river system as well as for breeding. It was observed that the dolphins preferred the habitat with deep pools. However for feeding they were sometime observed in the shallow zones and river meanderings. The dolphins were found to prefer depths ranging from 1.5 m to 4.3 m in various seasons during the study.

It was also recorded that the dolphin prefer a pH 7.05 to 8.70 in the intensive study area. The analysis of pH is essential in the dolphin habitat because it determines the intensity of acidity or alkalinity and concentration of hydrogen ion in the habitat.

During the study, it was observed that the dolphin prefers a habitat with minimum transparency of 3 cm. It was also observed that in the Ganges the turbidity is high during the monsoon, whereas transparency was maximum during the dry season in the upper reaches of the river.

The Ganges river dolphin is not a selective feeder but is a catholic feeder eating whatever fish species is locally available. They feed on small fishes ranging between 3.5 to 11.8 cm, crustaceans, mollusks, small soft shelled turtles and crabs. A large number of such species are found in the river system. Unfortunately, humans interfere with the availability of food of the dolphins. At least 8 species of small size fish (*Pangasius pangasius*, *Clupisoms garur*, *Mystus seenghala*, *Salmostoma bacaila*, *Mastacembelus armatus*, *Mystus bleeker*, *Cirrhinus reba* and *Sisor rhabdophorus*) known to be preferred by the dolphins (Rao 1995) are also caught by fishermen in the dolphin habitat in this stretch.

The details of the habitat preferred by the Ganges river dolphin for various activities in the upper Ganga river stretch is summarized in Table 1.



Typical dolphin food;
small size fish (6–8 cm)

Table1**Dolphin Habitat Parameters in Upper Ganga River (Narora to Bijnor)**

River stretch Kms	Km	Few Important Habitat Parameters
Mid Ganga River		
Narora– Anoopshehr (Zone I)	0 – 30	<p>Deep pools, sandy and muddy riverbank islands with vegetation</p> <p>River depth 1.5–4.3 m River width 200–800 m River velocity 3.0–5.5 m/sec</p> <p>Air temp.10–42 °C Water temp.12–28 °C</p> <p>pH 7.05–8.70 Dissolved Oxygen 6–8 mg/l Conductivity 200–250 µS/cm</p>
Anoopshehr– Farida (Zone II)	30 – 55	<p>Moderate deep pools, sandy and muddy riverbanks, sandy islands</p> <p>River depth 1.0–4.0 m River width 200–800 m River velocity 2.0–4.5 m/sec</p> <p>Air temp.10–42 °C, Water temp.12–28 °C</p> <p>pH 7.05–8.70 Dissolved oxygen 6–8 mg/l Conductivity 200–225 µS/cm</p>
Farida – Brijghat (Garhmukteshwar) (Zone III)	55- 85	<p>Deep pools, sandy and muddy riverbanks, sandy islands</p> <p>River depth 1.0–4.5 m River width 200–800 m River velocity 2.0–4.5 m/sec</p> <p>Air temp. 10–42 °C, Water temp. 12–28 °C</p> <p>pH 7.05–8.70 Dissolved oxygen 6–8 mg/l Conductivity 200–350 µS/cm</p>

Brijghat – Makdoompur (Zone- 1V)	8.5 – 125	<p>Shallow and moderate deep pools, sandy and muddy riverbanks, deep pools at Brijghat (near railway bridge)</p> <p>River depth 1.0–4.3 m River width 200–700 m River velocity 2.0–3.5 m/sec</p> <p>Air temp. 10–42 °C Water temp. 12–28 °C</p> <p>pH 7.05–8.70 Dissolved oxygen 5–7.5 mg/l Conductivity 200–350 µS/cm</p>
Makdoompur– Bijnor (Zone V)	125–165	<p>Shallow and moderate deep pools, sandy and muddy riverbanks, very shallow water at the Bijnor Barrage</p> <p>River depth 1.0–3.0 m River width 200–800 m River velocity 2.0–3.5 m/sec</p> <p>Air temp. 8–42 °C Water temp. 12–28 °C</p> <p>pH 7.05–8.70 Dissolved oxygen 6–7.5 mg/l Conductivity 200–250 µS/cm</p>

Based on WWF-India's study (2007–2009)

The population of dolphins in the study area was recorded to have increased (44 in 2007; 49 in 2008; 56 in 2009) during the project period (2007–2009). This signifies that the recruitment and growth pattern of the population is increasing. This is most likely because of the improvement in habitat conditions, as well as in the water quality. A decrease in the death rate between 2007–2009 could also be a factor as no death was recorded in this stretch.

Understanding the Riverine Turtles

WWF-India's work on fresh water turtle conservation began in year 2007. As an indicator species, freshwater turtle can provide invaluable information on the health of the Ganges river ecosystem. To evaluate the present health of the Ganga River and to understand the suitability of the

river for survival of turtles, data needed to be collected on turtle populations and other associated species.

Habitat Preference

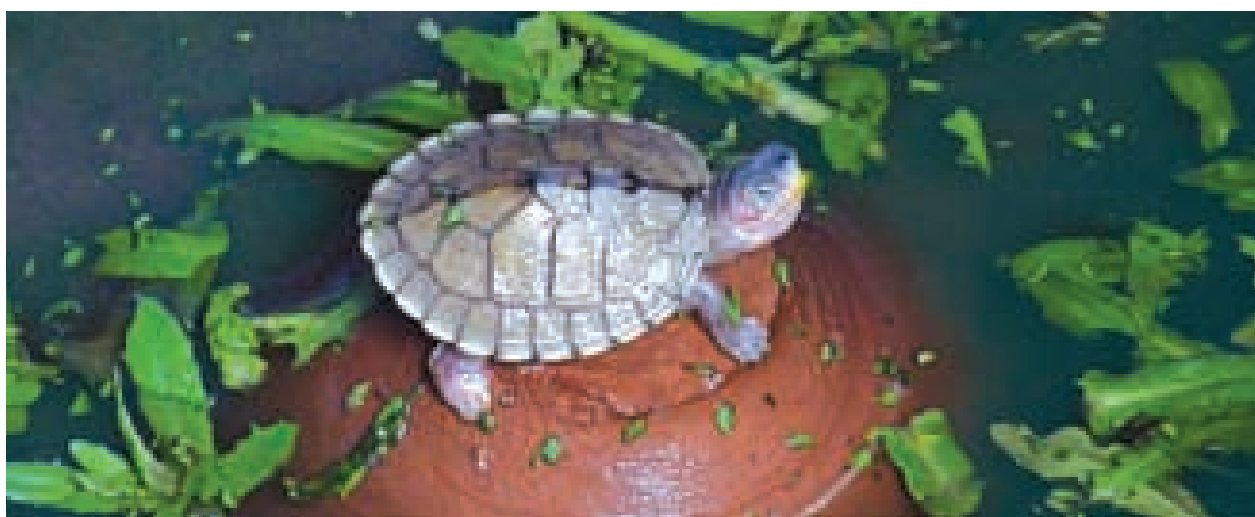
Between 2007 and 2009, a study was carried out to understand the distribution, habitat preference/utilization and conservation status of different freshwater turtle species in the Ganga river in a stretch of approximately 650 kms from Rishikesh to Kanpur.

Methodology

Habitat types were identified by recording river bank condition, vegetation characteristics (both aquatic and terrestrial) and water depth during summer.

The habitat preferences of each turtle species was determined by field observations. Whenever turtles were sighted, the observations with respect to the species (if easily identified), number, sex, location, bank type, vegetation, river depth and velocity were recorded in the field map-sheets. All such observations were recorded considering the turtles' activities like basking, nesting and feeding.

In order to describe the habitat preference of the turtles, the upper Ganga river was classified into the following habitat types, depending on the nature of the bank and the river depth during the dry season.



Turtle sp. (*Pangshura tecta*)



Turtle caught in a fishing net

Type 1: Both the banks are muddy, formed by the soil erosion of the adjacent land. The river depth varies from 3 to 6 m. Most of these banks are used for extensive agriculture. Turtles bask on the banks.

Type 2: One bank is sandy and the other bank is either muddy or hard soil. The river is shallow as well as very deep (2 to 6 m). Sand bars and sand peninsulas are present. Mid river islands with alluvial deposits are also present. There

are alterations to the sand banks every year due to erosion and deposition during monsoon high water. Hard-shell turtles construct nests on the sand banks and islands for laying eggs. The sand banks are extensively used for agriculture mostly of water melons and vegetables during different seasons.

Type 3: At many places long rivulets bring in rain water from the surrounding catchment areas. Some of these canals extend more than 1 km from the main river. During the monsoon season, the flood waters enter into the canals and the water level fluctuates depending on the rains. These canals are totally dry during a major part of the year. Villagers practice agriculture in these canals after the monsoon season. The soft-shell turtles nest in these canals.

Type 4: Due to the construction of many barrages at Rishikesh, Haridwar, Bijnor and Narora, the water has been stored upstream of barrages, forming large reservoirs. Downstream of the barrages, the river is very shallow with low water velocity. Soft-shell turtles live in the flowing waters as these animals require large tracts of sand banks for nesting.

Fresh water turtles in the Ganga river use all the above mentioned habitat types for basking, feeding and nesting.

Findings

Out of 28 species of freshwater turtles found in the rivers of India, 12 species are recorded in this stretch of the Ganga river (see Table 2).

Based on collections of shell and live specimens, eight species belonging to four genera and one family of hard-shell turtles (66.6 per cent), and four species belonging to three genera and one family of soft-shell turtles (33.3 per cent) were identified in the Ganga river.

Table 2

Freshwater turtles in the Ganga River between Bijnor and Kanpur

FAMILY	GENUS	SPECIES	ENGLISH COMMON NAME
Emydidae	<i>Hardella</i>	<i>thurjii</i>	Crowned river turtle
	<i>Geoclemys</i>	<i>hamiltonii</i>	Spotted pond turtle
	<i>Melanochelys</i>	<i>trijuga</i>	Indian black turtle
	<i>Batagur</i>	<i>kachuga</i>	Red-crowned turtle
	<i>Pangshura</i>	<i>smithii</i>	Brown roofed turtle
	<i>Pangshura</i>	<i>tecta</i>	Indian roofed turtle
	<i>Pangshura</i>	<i>tentoria</i>	Indian tent turtle
	<i>Batagur</i>	<i>dhongoka</i>	Striped roof turtle
Trionychidae	<i>Lissemys</i>	<i>punctata</i>	Indian flapshell turtle
	<i>Chitra</i>	<i>indica</i>	Narrow headed soft-shell turtle
	<i>Nilssonia</i>	<i>gangeticus</i>	Indian soft-shell turtle
	<i>Nilssonia</i>	<i>hurum</i>	Indian peacock soft-shell turtle

Source: WWF-India's present study

In the present study different species of freshwater turtles were sighted in various zones of the river. They have specific habitat requirements. The ecological parameters of turtle habitat are shown in Table 3.



Soft-shelled Turtle

Table 3**Ecological parameters of freshwater turtle habitat in the Ganga River between Bijnor and Narora**

Study Area	Habitat parameters	Species available
Bijnor–Narora	<p>Sandy and muddy banks, deep pools, sandy peninsulas, very shallow river after Bijnor Barrage, Reservoir upstream Narora Barrage</p> <p>River depth 0.5–20.0 m River width 200–1000 m River velocity 11.1 m/min (minimum)</p> <p>Air temp. 4.0–45.5 °C Water temp. 12.0–34.5 °C</p>	Fish (stray cases of mahseer), turtles, crocodile, wetland birds, Ganges river dolphin, Gharial and Mugger

Based on WWF-India's present study

The Ganga river in the study area has different habitat characteristics as already mentioned. Turtles occupy various habitats suitable to their requirements. The habitat utilized by identified species of turtles present in the study area are given in Table 4:

Table 4**Habitat utilization of identified turtle species (Bijnor to Narora)**

S.No.	Species	Habitat preference
Emydids species		
1.	<i>Hardella thurgi</i>	Totally aquatic species restricted to deep water 3 to 15 m deep. This species is found in 1.5 to 2 m deep water. Body covered with algae and detritus matter signify deep habitat preference. It comes to littoral zone for feeding.
2	<i>Geoclemys hamiltoni</i>	Found in 0.5 to 1.5 m deep water under submerged aquatic hydrophytes like <i>Potamogeton</i> spp., <i>Vallisneria</i> spp. and <i>Hydrilla</i> spp. where molluscs remain attached to them. Top cover of the hydrophytes hide this species.
3	<i>Melanochelys trijuga</i>	The species occurs in choked water with foul smell. It remains hidden in emergent vegetation like <i>Cynodon</i> spp., <i>Ipomea</i> spp., <i>Eichhornia</i> spp., and <i>Typha</i> spp. It is found actively moving in marshy and terrestrial areas in summer.

4	<i>Batagur kachuga</i>	Deep water with considerable velocity, not very fast (0.6 m/sec), 1.5 to 4.5 m deep, basin soily or silty.
5	<i>Batagur dhongoka</i>	Deep water with considerable velocity, not very fast (0.6 m/sec), 1.5 to 4.5 m deep, basin soily or silty. <i>Kachuga dhongoka</i> prefers shallow water of 1 to 1.5 m deep.
6	<i>Pangshura tentoria</i>	This species prefers slow moving intermittent pools of river under submerged hydrophytes and backwater along with <i>Kachuga smithii</i> . Juveniles with submerged hydrophytes and algae.
7	<i>Pangshura tecta</i>	In blocked water with no water current, mostly in submerged and emergent vegetation in the marshy area with <i>Sagittaria</i> spp., <i>Ipomea</i> spp. and <i>Polygonium</i> spp. Juveniles in less deep water 0.3 to 1 m deep under rich algal growth
8	<i>Pangshura smithi</i>	Slow water current, juveniles occur in backwater, shallow natural excavations with algal growth 0.3 to 0.6 m deep. Adults prefer deep side pockets and deep pools with sandy basin.
Trionychids species		
9	<i>Lissemys punctata</i>	Prefers fresh, slow-moving water and marshy ponds under submerged hydrophytes like <i>Hydrilla</i> spp., <i>Potamogeton</i> spp. and <i>Ceratophyllum</i> spp. etc. where molluscs are abundant. Muddy basin is preferred.
10	<i>Chitra indica</i>	Low water depth with a considerable velocity; usually hide in gently slopping sandy basin of intermittent pools of river with vegetation and algae. Only protruding pointed snout and head enable sudden attack on prey like fishes and insects. It is found foraging along the littoral zone.
11	<i>Nilssonina gangeticus</i>	Deep intermittent pools of 1.5 to 4.5 m or more and flowing water particularly steeply sloping pools near the lower side of sandy islands where two streams confluences to form a common slow flowing deep reservoir. Algal components with sandy basin is required.
12	<i>Nilssonina hurum</i>	Found in deep pools with dense hydrophytes and molluscs. Most of marshy side deep pools have been preferred by the species.

Based on WWF-India's present study

Suitable hydrological conditions are important for turtles to survive. Two key variables were studied to quantify the suitability of the water component: River velocity and depth. Turtles prefer river velocity ranging between 20 to 70 cm/sec. Sections of the river with much higher velocity or lower velocity are avoided in favour of the moderate velocity areas. This assumption is appropriate for a typical river with an average width of 500 to 1500 metres. A wider river or a narrower stream may not provide this average velocity as the wider river may have lower water velocity and narrow stream have higher water velocity.

The turtles often occur in water bodies with deep pools. The deep water provides them breeding habitat as well as food and cover. However, for feeding they use the shallow stretch of the river. Shallow waters usually provide proper cover for young turtles.

A river containing permanent water will have the highest likelihood of supporting turtles throughout the year. River stretches where water is not plentifully available are less suitable for big turtles like *Nilssonia gangeticus*,



Nilssonia gangeticus: basking habitat

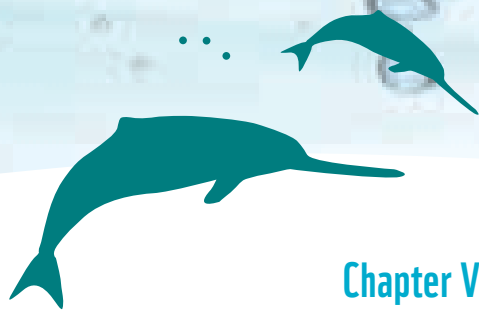


Pangshura smithii: basking habitat

Batagur kachuga, *Batagur dhongoka* and *Hardella thurgii*. Turtles move from such stretches to other areas where large quantities of water are available.

Freshwater turtles show both daily and seasonal activity patterns. Daily activity patterns represent feeding and basking, while the reproduction of turtles is a seasonal activity. All of these activities are influenced by changes in temperature. Basking behaviour of all hard-shell turtles are similar. During basking they raise their heads at an angle of 45° and rarely move far from water. The neck and limbs are fully extended to allow maximum sunlight on the soft part of the body. Basking turtles are easily startled when approached. Basking does not occur all along the riverbank. There are certain preferred sites which are used everyday.

During the present study, all age and classes of each species were frequently encountered. This is a good indication of successful natural breeding of turtles in the upper Ganga River. The feeding, basking and nesting sites were observed throughout the study stretch. Large stretches of sandy and muddy banks on either side of the river provided good nesting sites as well as basking sites for different species of turtles. The deep pools at various stretches of upper Ganga river provided large quantities of food for turtles.



Chapter V

CONSERVING WITH COMMUNITIES

Successful river management needs good information, effective and holistic strategies apart from strong implementation. This depends on resources, priorities and political will of and the support of local people dependent on the river. During the initiation of the programme in the late nineties, WWF–India, therefore, attempted to establish a ‘social approach’ to the conservation of the Ganga river’s aquatic biodiversity and

ecosystem functions. This was based on informing and motivating local people through education/awareness programmes for rural communities whose activities contributed directly or indirectly to the degradation of the river system.

Public meetings were arranged, initially through building relationships with village leaders. During such meetings, local people were provided with detailed information about the river and the value of aquatic ecosystems in general. Young volunteers were trained and given responsibilities to organize community-based education and awareness activities, including street plays, storytelling, slide shows, film shows and expert presentations in the local language. This work was supported by a detailed socioeconomic study of 29 riverbank villages in between Bijnor to Narora, initiated in 2003, to ensure that the full range of interactions between local people and the river are well understood. In 2004, Farida village was selected for intensive intervention as it was found to be highly dependent on the river resources.



Intallation of traditional
sewage treatment system
at Karnabas village

Farida village: participation in conservation and development

An intensive programme was implemented in Farida village in Uttar Pradesh by WWF-India during 2001–2004 as a pilot project to understand the linkages between conservation initiatives and sustainable livelihoods, and help in formulation of suitable policies. A detailed study was also undertaken to quantify the changes in livelihood assets, examine the effect of conservation



Village meeting at Farida

initiatives in developing livelihood strategies and understanding the contribution of the programme to enabling good governance. The results indicated that the conservation programmes motivated people in changing their livelihood strategies and thereby contributing to dolphin conservation. These changes included reduction in fuelwood consumption and fishing activities in the adjacent river stretch, as well as shifting from the use of chemical fertilizers and pesticides in their agriculture to organic inputs. The villagers were also increasingly made aware of several livelihood improvement schemes of the government.

The conservation programmes helped build confidence of the people to demand good governance in the village, thereby ensuring successful implementation of various development schemes of the government that support their livelihoods. The positive effects on their livelihood, identified during the case study, includes the decline of poverty, decline in the landless households and increase in livestock as well as other household assets. The study shows linkages between the conservation initiatives and social development (Manoharan and Behera 2006).



Village meeting at Farida



Considerable emphasis has all along been placed on the religious symbolism of the Ganga and the river dolphin. A comprehensive education programme was designed using the dolphin as a Flagship species to foster deeper understanding of the river ecosystem and to promote simple conservation measures such as the replacement of chemical fertilizers with cattle dung. Public opinion was significantly influenced by the support of religious leaders and other respected community figures. The local media was very responsive and gave good coverage to WWF's activities involving the riverbank communities. Although there was no direct economic incentive for the local people to change their attitudes or behaviour, they realized that in the long run they stood to gain from the increased fish production of a healthier river system.

Some significant achievements from the first phase (1997–2006) of WWF-India's programme are given below:

- Establishment of the *Ganga Sanrakshyan Samiti* (Ganges Conservation Committee), a local-level body composed of all project partners, responsible for conducting and monitoring river conservation activities.
- Restriction in the use of plastic bags in townships along the river near Narora, following a campaign by WWF-India in 2002.
- Tree plantation along 5 kms of the main road and the bank of the river near Narora township, undertaken with support from the Narora



Plantation in village

Atomic Power Plant Corporation, the local administration and local NGOs. This has improved riparian vegetation cover and helped to control flooding and reduce soil erosion, both of which were major problems in the area.

WWF-India's conservation efforts with the communities living on the riverbank has had a positive impact on the habitat of fresh water dolphins and turtles. This has been possible because special initiatives were undertaken to garner community support for conservation, an approach in which WWF acquired rich experience from 1997 onwards, particularly through its community-based work in Farida village. This experience was invaluable as it provided in-roads for WWF to undertake work in the later phase (2007–2009), when more sophisticated tools and methods were used.

Participatory Rural Appraisals (PRAs), micro spatial vulnerability assessments and other scientific research outputs were collated to develop a comprehensive adaptation strategy to build resilience of select village communities in the upper Ganga region, towards extreme events such as changes in river velocity, temperature impacts on crops, biodiversity. The strategy was formulated in collaboration with the government, scientific institutions and the local communities.

Along with biodiversity conservation, the project work undertaken from 2007 also focused on adaptation strategies such as bank restoration, alternate and improved livelihoods, collection and protection of turtle nest in natural condition and release of the hatchlings, installation of traditional STPs and use of vermicompost in agriculture, in two pilot villages in the Upper Ganga River. The pilot sites for implementation and development of the project were Karnabas and Mubarakpur villages located in Bulandsahar district of Uttar Pradesh.



Mubarakpur - A pilot village

Profile of Pilot Villages

The two villages, Karnabas and Mubarakpur, are located on the banks of the upper stream of the Ganga river in Bulandsahar district of Uttar Pradesh (UP). While Karnabas is famous for the Karna temple of Mahabharata fame, Mubarakpur is equally famous for the Maa Avatika Devi temple. However, comparatively speaking, both the villages are quite apart in terms of levels of socio-economic development as well as the nature of socio-economic and environmental problems faced by the villagers. Karnabas is a slightly developed village, while Mubarakpur is an impoverished village. Karnabas is a popular destination for religious tourism and is also a sensitive environmental site being the habitat of freshwater Ganges river dolphin, popularly known as 'Sauns' in Hindi. In Mubarakpur village very few basic and modern facilities are available. Since a majority of the villagers do not have land ownership rights and the level of education is somewhat low, they mostly work as daily labourers.

Most people in both the villages have their own houses and a majority live in joint families. The literacy rate in both the villages is above sixty per cent. A large number of families in both villages fall under the BPL (Below Poverty Line) category, and only a very few are beneficiaries of government developmental schemes. In Karnabas, the main occupations of the villagers are farming and allied activities, agricultural and non-agricultural labour, service professionals and trade and commerce, whereas in Mubarakpur, the main occupations of the residents are farming and agricultural labour. In Karnabas, the youths are also educated but a majority of them are unemployed. While Karnabas is fully electrified and a majority of its residents have electricity connections, Mubarakpur village is yet to be electrified. The



Discussion at Mubarakpur village

main problems of both these villages were discussed and some solutions suggested by the villagers were noted through Participatory Rural Appraisal (PRA) and Focused Group Discussion (FGD) exercises. This was presented by drawing a resource map in consultation with the villagers.

With regard to livestock and grazing pattern, the data and popular opinion through FGD reveals that there are definitely changes in milk yield, mainly because of loss of grazing land and rise in temperatures, but also because of the spread of various diseases affecting domestic animals. People also complained that buffaloes were being injected with oxytocin to produce more quantities of milk, but as a result the quality of milk was going down. Some respondents also felt that climatic changes had affected domestic animals in terms of productivity, health and diseases (though no scientific evidence of this could be found).

The health scenario data reveals that majority of the people from both the villages use open defecation for toilet purpose, and the main type of diseases are malaria, dengue and diarrhoea. In the case of Mubarakpur, it was observed that health standards are extremely poor and there is no primary health centre available.

From people's perspective, the water quality of the Ganga river has severely deteriorated in recent years, with the main threat being pollution. People primarily blamed the industries and ineffective government policies. It was generally accepted by the knowledgeable local people that the Ganga Action Plan had failed to protect the river until now as the existing sewage treatment



tanks were not effective in controlling the outflow of polluted water for a variety of reasons. Despite all this, the traditional reverence for the sacred river remains strong.

With regard to water and irrigation, the survey shows that the main sources of drinking water are open wells and tubewells and a majority of the people feel that the water is polluted, however, it is available without much difficulty. Many prefer soil management by making *bunds* (embankment), and *nallahs* (drain) are considered the best way to manage water resource sustainably. The majority of respondents used water from the Ganga in times of drought.

With regard to various adaptation strategies, a majority of the households have no safeguards against natural calamities like cyclones, earthquakes and floods. This is especially true in Mubarakpur, which is an underdeveloped village and housing structures in this village are mainly kutcha (temporary structure). 50% of the respondents in Karnabas village felt that they had the capacity to adapt to environmental change, while the majority in Mubarakpur felt they did not have adequate means to face any adverse environmental changes due to their poor socio-economic condition. During a public consultation, people in Mubarakpur complained that the central government schemes to provide housing to the poor are not being implemented adequately. Nevertheless, in both the villages, people expressed their need for help during unforeseen situations that may arise due to adverse effects of climatic change.



Village meeting at Mubarakpur

WWF's work with local affected populations suggests that achieving sustainable livelihoods for them would require the integration of local knowledge and community strengths with appropriate technology, enabling policies, effective and transparent governance structures, education and training, and consistent

awareness campaigns and investment. The local communities in the two selected villages also suggested that while communicating with the policy makers, WWF-India should present the interests of both - the poor people and the ecosystem as a whole to foster sustainable development. In conclusion, a social democratic approach with local people's involvement could well be an appropriate strategy to promote sustainable development in the villages of the Ganga river basin.



Turtle nest conserved by the farmers

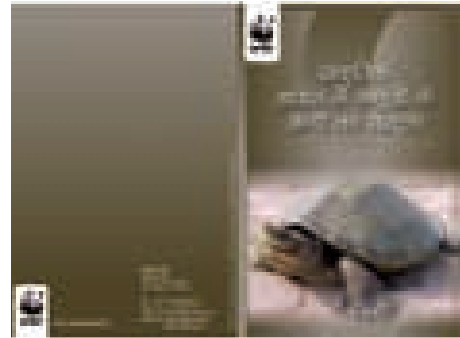
Conservation activities in Pilot Villages

When it is difficult to conserve the species in its natural habitat due to various threats, some level of protection through local community participation may be extended. The local community in this case provided all manner of support to conserve the eggs of the turtles in safe areas which had characteristics similar to the turtles' natural environment.



Turtle nest conservation by island farmers (Karnabas)

The conservation of turtles in River Ganga was initiated by WWF-India for Indian tent turtle, Indian roof turtle and Brown roof turtle. Among these, the Indian roof turtle is in Appendix 1 of CITES and in Schedule 1 of Indian Wildlife Protection Act (1972).



Awareness booklet for the farmers

The dynamics of River Ganga is very unpredictable. The villages on the banks of the river face the problem of erosion every monsoon. Many villagers who have their farmland close to the river, lose their land in every flood. So, the villagers started practicing island farming in the dry season from October to June. These islands are very good for the crop of Cucurbitaceous family.

The farming time, that is, October coincides with the nesting season of these three species of turtles. Prior to the initiation of our conservation efforts, their nests were either damaged during farming activity or they didn't get a proper site for egg-laying.

The WWF-India team initiated an awareness programme to target the local communities, particularly those practicing island farming. The team spread knowledge about the importance of the species in river conservation and convinced them to co-operate in conservation. In this context, WWF-India



Village meeting at Mubarakpur



Village Resource Map - Karnabas

came up with enclosed hatcheries in safe places within their habitat.

The farmers, whenever they found any turtle nest while farming, the eggs were safely placed in enclosed hatcheries, where the chance of depredation and other dangers to the eggs was minimized. This programme was initiated in Karnabas village in the year 2006 and replicated successfully in the adjoining villages of Udaipur, Mubarakpur, Baheria and Sherpur.



Construction of embarkment
at Sankratilla village

More than 2100 hatchlings were successfully released in the River Ganga in between 2007 to 2009 by the local villagers.

Agricultural pollution from pesticides, chemical fertilizers and riverbank erosion are the major threats in the selected river stretch. WWF-India's intervention since 1997 have led to considerable improvement in water quality and riverbank stabilization (Behera et.al 2005), resulting in the improvement of aquatic habitats.



Traditional sewage treatment plant installed at village Karnabas

The government department responsible for soil conservation has taken necessary action against soil erosion in Karnabas village. They have made 25 embankments along a stretch of 5 kms of river- bank to check erosion. Moreover, check dams have been constructed in a 6 sq km area for watershed management.



Village meeting at Farida

During this phase (2007-2009) the following activities were implemented in collaboration with communities and the local government to continue the conservation initiatives.



Awareness rally at Mubarakpur

- Around 5,000 seedlings were planted on the riverbanks to protect soil erosion.
- Pasture land of (8 hectare) was developed in the gram panchayats of Karnabas and Mubarakpur village to facilitate grazing.
- Thirteen water harvesting/check dams were developed by the local government in Karnabas and Mubarakpur village, to protect soil erosion.
- 25 stone embankments were constructed in a stretch of 5 kms of riverbank to check bank erosion.
- 120 vermicompost units were setup and are still running to benefit almost 80 farming families. They are using composting for island crops as well as seasonal crops. Around 45 hectares of riverbank land is fertilized by the use of vermicompost. The district administration has released a government order to give subsidy to the farmers for vermi-farming, which will have a significant role in reducing the pollution load on the river.
- Traditional low cost Sewage Treatment Plant (STP) to treat domestic sewage, was installed in Karnabas village and is running successfully. Based on this work, the district administration has identified WWF-



Watershed development to prevent soil erosion

India as a technical partner to develop similar STP's in nearby villages and towns

- Motivation workshops and an annual community outreach programme (*Ganga Maha Utsav*) was organized at Karnabas and Mubarakpur village.



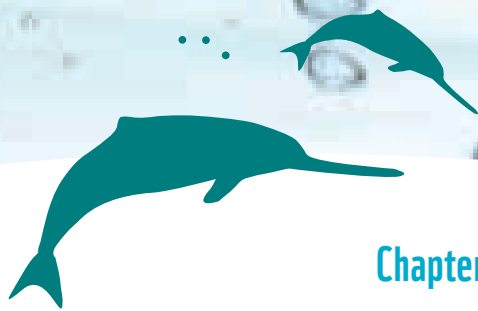
Afforestation by the Forest Department to stop soil erosion at Brij Ghat

- Awareness material on the river dolphin and turtle-nesting sites were developed and distributed.

During the duration of the project, various district administrators (District Collectors, Circle Development Officers, Block Development Officers) visited the project sites to learn the process WWF-India had adopted, in order to implement it in other neighbouring villages. The local government has already adopted 20 more villages on the lines of WWF-India's village models to change water-use policies and practices in the project area, and to contribute towards conserving the environment.



A vermicomposting unit at Mubarakpur



Chapter VI

CONSERVATION IMPACT AND ACHIEVEMENTS

The quantity and quality of water is not only necessary to sustain human life, but are also key factors to sustain aquatic biodiversity. The change in behavioural patterns of aquatic life, such as migration pattern and breeding, apart from food

availability and loss of biodiversity, will affect the ecology of the river system. Therefore, planning for conservation and optimal utilization of this scarce resource is extremely important for economic development as well as the survival of aquatic biodiversity.

One of the objectives under the project was to study the climate change impacts on the biodiversity, specifically the Ganges river dolphin and the freshwater turtles. The project time frame was too short to assess the direct impacts of climate change on various aspects of biodiversity discussed above. The result of the research has given an insight into the impact of availability of water in the river in different seasons on the Ganges river dolphin and habitat requirements for the species. This can play an important role in determining habitat management strategies for these species in the face of climate change. The successful conservation efforts in the selected villages like Karnabas and Mubarakapur, located on the bank of the Ganga, resulted in restoration of selected habitats of the endangered dolphins and turtles.

The partnership of WWF-India with the local *panchayats* and various government departments has increased the effective implementation of the project at various levels resulting in livelihood improvement, which includes the development of the social status of the villagers through various government village development schemes such as Indira Awas Yojana, clean toilet programme, soil conservation and watershed programme.

The implementation of a few adaptation strategies such as development of watersheds and promotion of vermicompost has helped the farmers improve their crop productivity. The tree plantations along the riverbanks and construction of stone embankments along various stretches done by the government and other partners with technical support of WWF-India has reduced soil erosion on the riverbank. It can be said that improvements in the dolphin habitat by reducing the environmental threats, are the result of improved awareness among local community.

The adaptation work has benefited both the aquatic life and the local people who are dependent directly on the river in numerous ways for survival.



Acoustic research in progress to study underwater behaviour of river dolphins

Adaptation initiatives included improving water quality through the minimization of chemical fertilizers and pesticides use, afforestation along the riverside, the introduction of innovative methods to reduce fuel wood use and other measures to reduce soil erosion. This has also generated alternative livelihood options that put less pressure on the natural environment.

Outcomes and Insights Gained

The three year project (2007–2009) resulted in achieving most of the planned targets successfully; however, the result of the research indicates that any such study that attempts to understand the impact of climate change on particular species and the people needs a longer timeframe. The study of water quality and quantity needs more research and this is vital to sustain a living healthy river. However, it is imperative to continue working with locally developed adaptation strategies to improve the utilization of the available water resources.

Some of the insights gained on aquatic species habitats are:

- Studies on water availability and water quality in the upper Ganga river was carried out in order to understand the factors determining the flexibility and adaptive capacity of ecosystems, including the habitat preference of the species, river connectivity and quality, flow regimes,

disturbances and mortality of the aquatic biodiversity specially of Ganges river dolphins and freshwater turtles.

- Research on diurnal and seasonal migration of the Ganges river dolphins (see Appendix IV) and freshwater turtles could be related to the availability of water in the river in different seasons, which indicates the habitat requirements for the species.
- Climate and hydrological data, compiled and documented, indicates impacts on river velocity, biodiversity and livelihoods. Mapping of the existing land cover land use of the region (10 km buffer) with a focus on the river, using remote sensing and GIS also helped in knowing the change in the river condition as well as the land cover.

Some of the important insights with respect to species conservation are:

- Monitoring of the Ganges river dolphin population needs to be continued in the long term.
- Measures have to be taken to reduce the pollutants reaching the Ganga river through various modes.
- Over-exploitation of fish in the study area needs to be controlled.
- Biological monitoring is essential for the proper management of the Ganga river ecosystem and biotic resources. Status of all endangered animals like turtles, crocodiles and migratory birds needs to be monitored systematically. Monitoring is also required to provide information on rates of change in population size and structure.
- Good population of higher vertebrates in the aquatic systems indicate



Children participating in an Awareness Programme

a good population of other sympatric species and a safe, less disturbed habitat. Hence, human activities like agriculture and stone/sand mining on the riverbanks need to be controlled, and floodplains need to be restored to allow the natural breeding of aquatic animals such as fish, turtles and crocodiles along with river dolphins.

- Evaluation of various aspects like species diversity and population status of aquatic animals requires long-term studies. This will also help to formulate a proper management plan for the conservation of the riverine stretch.
- There is a rich biodiversity of aquatic animals and their habitats which currently do not receive any formal, legislation-based protection. Informally, religious institutions help protect some species at the bathing ghats and the irrigation department provides a limited amount of protection at some of the barrages. Hence, there is a need for greater protection by declaring this river stretch as a 'Dolphin Sanctuary'.

The research work also suggests an increase in the dolphin population from 44 in the year 2007 to 56 in the year 2009 in the study area. Turtle nests were conserved in different turtle habitats for the indigenous turtle species of Ganga. Around 400 nests of selected turtle species (*Pangshura smithii*,



Farmers transporting vermicompost to be used as fertilizer

P. tecta and *P. tentoria*) were conserved and more than 2100 hatchlings were successfully released in the River Ganga in between 2007 to 2009.

Some of the other gains from the project include the following:

- Development of data base and research through GIS and remote sensing is an extremely valuable asset that has been created for further research and will help to formulate adaptation strategy where required, as also a long-term policy to save the ecosystem.
- The lessons learned from WWF-India's intervention, particularly its strategy with regard to garnering support from the local communities, has been widely disseminated and accepted by the government and local people as a replicable model.
- The principle of involving local people in conservation as direct stakeholders has been accepted and embraced by the authorities. This is a significant achievement as there is ample evidence of failure of even the best schemes where local people have been by-passed.
- Advocacy work to scale up and buy-in by the government has been an important component of the project. WWF-India is now in the process of advocating and scaling up its work with the active involvement of the government and the concerned local authorities.
- Involvement of WWF-India in national committees like NGRBA, demonstrates that WWF-India's contribution to conservation of the Ganga ecosystem has been recognized and this has brought further responsibility on the organization. WWF-India is now actively assisting the Government of India to develop a management plan for the Ganga river its ecosystem and the species.

REFERENCES

- Bashir, T., A. Khan, J.A. Khan, P. Gautam and S.K. Behera (2007), *Aspects of Ecology of Gangetic Dolphin (Platanista gangetica) in Western Uttar Pradesh, India (A survey report funded by WWF-India)*, Aligarh: Department of Wildlife Sciences, Aligarh Muslim University.
- Bashir, T., A. Khan, P. Gautam and S.K. Behera (2010), 'Abundance and Prey Availability Assessment of Ganges river dolphin (*Platanista gangetica gangetica*) in a Stretch of Upper Ganges River', *Aquatic Mammals*, Vol. 36, No. 1, pp. 19–26.
- Basu, D. (1987), 'Project for rehabilitation of freshwater turtle initiated in U.P', *Hamdaryad*, Vol. 12, No. 2, pp. 13–14.
- Behera, S.K. (1995), 'Studies on population dynamics, habitat utilization and conservation aspects of Gangetic dolphin (*Platanista gangetica*) in a stretch of Ganga River from Rishekesh to Kanpur', Unpublished Ph.D. thesis, School of Studies in Zoology, Jiwaji University, Gwalior, India.
- (2002), *Ganges river dolphin—Wanted alive! (Status report submitted to WWF-Sweden)*, New Delhi: WWF-India, Ganges river dolphin Conservation Project Research Report.
- Behera, S. K. and R. J. Rao (1999), 'Observation on the behaviour of Gangetic dolphins in the upper Ganga River', *Journal of Bombay Natural History Society*, Vol. 96, pp. 43–7.
- Behera, S. K., V. Sagar and A. Nawab (2008), 'Environmental flow requirements vis-à-vis habitat use pattern of freshwater dolphins', *Proceedings of the 11th International River Symposium (September)*, Brisbane, Australia.
- Bunn Stuart, E. and Angela H. Arthington (2002), 'Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity', *Environmental Management*, Vol. 30, No. 4, pp. 492–507.
- Daniel, J.C. (1983), *The book of Indian reptiles*, Bombay: Bombay Natural Historical Society.
- Islam, M.Z. and A.R. Rahmani (2004), *Important Bird Areas in India: Priority sites for conservation*, Bombay and UK: Indian Bird Conservation Network and Natural History Society and Birdlife International.
- Jones, S. (1982), 'The present status of the Gangetic susu, *Platanista gangetica* (Roxburgh), with comments on the Indus susu, *P. Minor*', Owen FAO Advisory Committee on Marine Resources Research, Working Party on Marine Mammals, *FAO Fisheries Series*, Vol. 5, No. 4, pp. 97–115.
- Krishnamurti, C.R., K.S. Bilgrami, T.M. Das and R.P. Mathur (1991), *The Ganga—A scientific study*, New Delhi: Northern Book Centre.
- Loarie, S.R., P.B. Duffy, H. Hamilton et al (2009), 'The velocity of climate change', *Nature*, Vol. 462, No. 24, pp. 1052–5.
- Manoharan T R & S K Behera 2006 - Ganges River Dolphin Conservation & Livelihood Assessment: Farida Village- A Case Study, in '*Species and People: Linked Futures*' - A report on the contribution of wildlife conservation to rural livelihoods and the MDG's, Ed by: O'Gorman, T.T. Lama, WWF, pp 65-71.
- Mishra, A. (2010), 'Assessment of Water Quality Using Principal Component Analysis: A case study of the River Ganga', *Journal of Water Chemistry and Technology*, Vol. 32, No. 4, pp. 227–34.

- Mohan, R. S. L., S.C. Dey and S.P. Bairagi (1998), 'On a residential dolphin population of the Ganges river dolphin, *Platanista gangetica* in the Kulsi river (Assam), a tributary of Brahmaputra', *Journal of the Bombay Natural History Society*, Vol. 95, No. 1, pp. 1–7.
- Moll, E.O. (1984), 'Freshwater turtles in India. Their status, conservation and management', *Hamadryad*, Vol. 9, No. 3, pp. 9–17.
- Pritchard, P.C.H. (1979), *Encyclopedia of Turtles*, New Jersey: T.F.H. Publications.
- Rao, R.J. (1990), *Ecological relationships among freshwater turtles in the National Chambal Sanctuary—Study report*, Mimeo, Dehradun: Wildlife Institute of India.
- (1995), *Studies on Biological restoration of Ganga river in Uttar Pradesh: An indicator species approach*, Final technical report, Project No. J-11013/10/92 GPD.
- Rao, R.J. and L.A.K. Singh (1986), *Ecological Relationship among turtles in National Chambal Sanctuary*, Interim Study Report 2, Deori, Morena: National Chambal Sanctuary.
- Reeves, R.R., S. Leatherwood and R.S. Lal Mohan (eds) (1993), *A Future for the Asian River Dolphins*, Report from a seminar on the conservation of river dolphins of the Indian subcontinent, 18–19 August 1992, New Delhi, India, Bath, U.K.: Whale and Dolphin Conservation Society.
- Shrestha, T. K. (1989), 'Biology, status and conservation of the Ganges river dolphin (*Platanista gangetica*) in Nepal', in W.F. Perrin, R.L. Brownell Jr., Zhou kaiya and Liu Jiankang (eds), *Biology and Conservation of the River Dolphins*, IUCN Species Survival Commission Occasional Paper No. 3, IUCN, Gland, Switzerland, pp. 70–6.
- Sinha, R. K., B. D. Smith, G. Sharma, K. Prasad, B. C. Choudhury, K. Sapkota, R. K. Sharma and S. K. Behera (2000), 'Status and distribution of the Ganges susu. *Platanista Gangetica*, in the Ganges river system of India and Nepal', in R.R. Reeves, B. D. Smith and T. Kasuya (eds), *Biology and Conservation of Freshwater Cetaceans in Asia*, Occasional Papers of the IUCN Species Survival Commission No. 23, IUCN, Gland, Switzerland, pp. 54–61.
- Sinha, R. K. and G. Sharma (2003), 'Current status of the Ganges river dolphin, *Platanista gangetica* in the rivers Kosi and Son, Bihar, India', *Journal of the Bombay Natural History Society*, Vol. 100, No. 1, pp. 27–37.
- Smith, M.A. (1933), *The Fauna of British India, including Ceylon and Burma: Reptila and Amphibia, Vol I—Loricata, Testudines*, New Delhi: Today and Tomorrow's Printers and Publishers.
- Smith, Brian D. and Randall R. Reeves (2000), 'Survey Methods for population Assessment of Asian River Dolphin', in Randall R. Reeves, Brian D. Smith and Toshio Kasuya (eds), *Biology and Conservation of Freshwater Cetaceans in Asia*, Occasional Papers of the IUCN Species Survival Commission No. 23, IUCN, Gland, Switzerland, pp. 97–115.
- Smith, B.D. and G.T. Braulik (2008), *Platanista gangetica*, in *IUCN 2010: IUCN Red List of Threatened Species*, Version 2010.3.
- Tikader, B.K. and R.C. Sharma (1985), *Handbook: Indian testudines*, Calcutta: Zoological Survey of India.
- Wong, C.M., C.E. Williams, J. Pittock, U. Collier and P. Schelle (2007), *World's top 10 rivers at risk*, Gland, Switzerland: WWF-International.
- WWF (2003), 'Managing Rivers Wisely: Lessons from WWF's work on Integrated River Basin Management', *Managing Rivers Wisely*, www.panda.org/livingwaters/publications.

APPENDICES

APPENDIX I

List of fishes identified from the upper Ganga river

Family: Clupeidae

Gudusia chapra

Family: Notopteridae

Notopterus chitala

N. notopterus

Family : Cyprinidae

Amblypharyngodon mola

A. melettinus

Barilus bola

B. barila

B. modestus

B. vagra

Chela laobuca

Catla catla

Tor tor

Tor putitora

Cirrhinus reba

C. mrigala

Crossocheilus latius

Danio devario

D. dangila

Family: Gobitidae

Botia dario

Nemochilus botia

N. corica

N. bevasni

N. montanus

N. zonatus

N. scaturigina

N. multifasciatus

N. savana

Lepidocephalichthys guntea

Family: Anabautidae

Colisa lalius

C. fasciata

Anabas testudineus

Family: Centropomidae

Chanda ranga

C. nama

Family: Nandidae

Nandus nandus

Family: Badidae

Badis badis

Family: Mastacembelidae

Mastacembelus armatus

M. puncalus

M. acculatus

Family: Belonidae

Xenentodon cancila

Family: Gobiidae

Glossogobius giuris

D. rerio

Gara gotyla

Gara prshadi

Labeo rohita

L. boga

L. calbasu

L. pangusia

L. gonius

Osteobrama cotio

Oxygaster bacaila

O. boopis

Puntius sophore

P. ticto

P. chola

P. sarana

Laubuca atper

Rasbora daniconius

Family: Siluridae

Ompok bimaculotus

O. pabda

Wallago attu

Family: Bagridae

Mystus vittatus

Mystus seenghala

M. cavausius

M. oar

M. tangara

M. bleekeri

Rita rita

Family: Sisoridae

Bagarius bagarius

Nangra nangra

Family: Chascidae

Chaca chaca

Family: Schilbeidae

Ailia colia

Clupisoma garua

Eutropiichthys vacha

Family: Pangasidae

Pungasium pungasius

Family: Heteropneutidae

Heteropneustes fossilis

Family: Clariidae

Clarias batrachus

C. magur

Family: Ophiocephaleidae

Channa gachua

C. marulius

C. punctatus

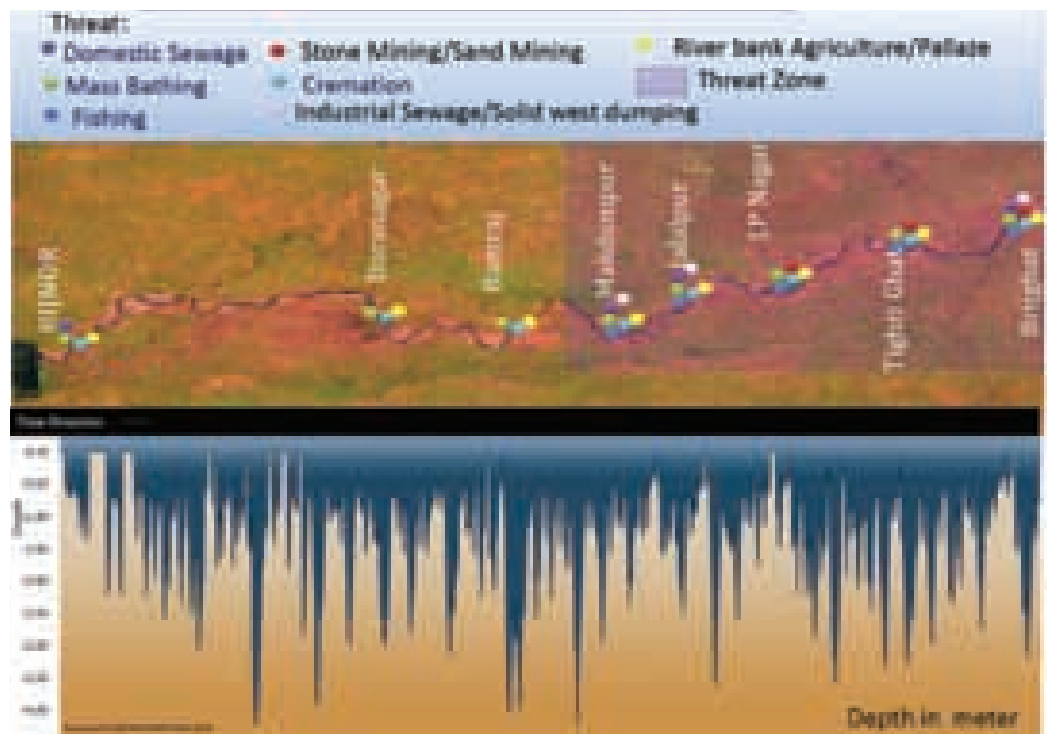
C. striatus

C. slewartii

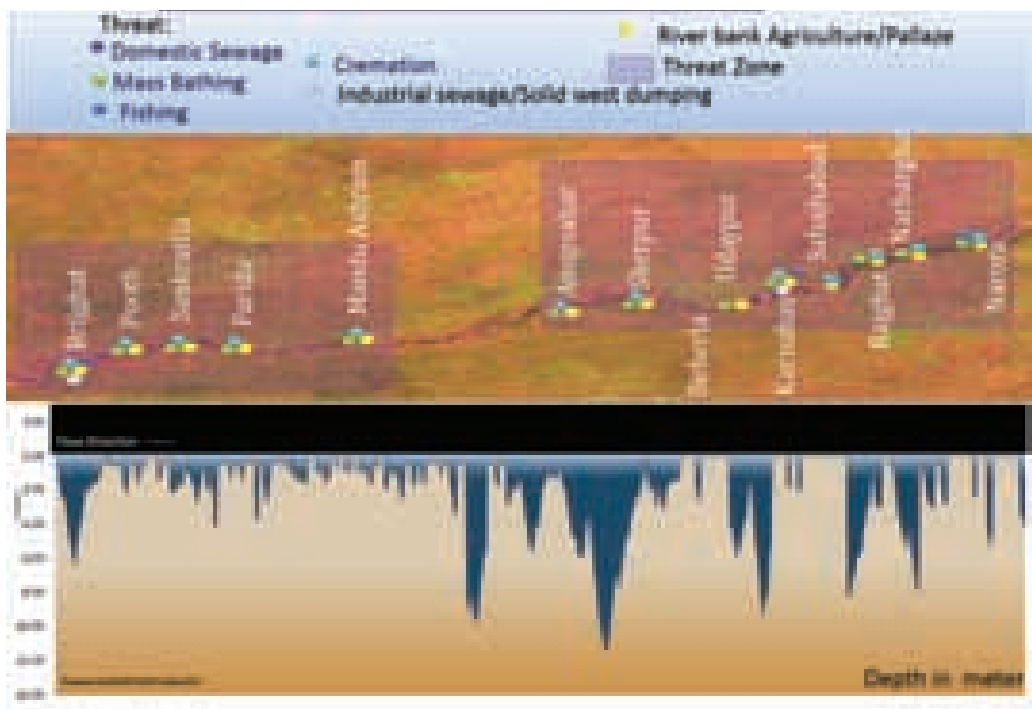
APPENDIX II

Identified threat zone in Ganga river (Bijnor to Narora)

Bijnor to
Brijghat



Brijghat to
Narora



Study of Ganga river basin with the use of geospatial technology around Bijnor to Narora region for communities, livelihoods and species

Introduction

Remote sensing and GIS (Geographical Information System) are the best methods to analyse the changes on the earth surface and classification of remote sensing based satellite imagery is very useful for quantifying the changes. However, complexity of landscape, sensor resolution and classification techniques can impact the accuracy of the results.

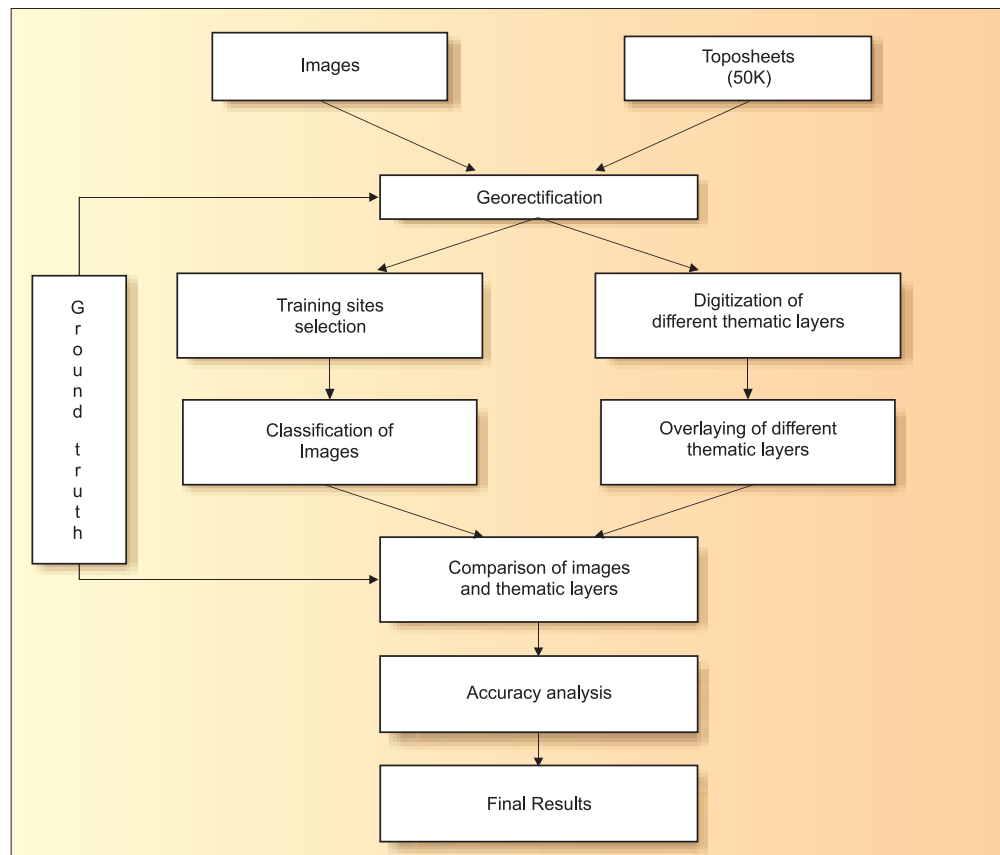
This study is an attempt to show the distribution of available wildlife and the habitat available in the study stretch. This study also demonstrate the changes in the path of River Ganga from Rishikesh to Narora (within a 10 km buffer area)—carried out by using geo-statistical techniques of the past 40 years—as a result of the developmental activities taking place in the study stretch. Further work was carried out to assess the threat posed by changes in land use/land cover to the aquatic biodiversity with specific emphasis on Ganges river dolphins and turtles.

Survey of India toposheets (1:50,000) of 1970s were compared with IRS-P6 LISS III satellite imageries for 1997 and 2007 to assess the changes in river topography. In certain stretches drastic changes in the river path was observed for the period between 1970 and 1997, with the changes extending to about 4 km from the original path. However, in the period between 1997 and 2007 the shift was comparatively small. The overall comparison however shows that the river channel is expanding. The obtained result indicates the fact that the width of the river channel is increasing, while the depth of the water channel is declining. Based on the results certain areas were identified as ‘critical areas’ requiring immediate protection and management interventions posed by changing river course.

Data Used

Survey of India toposheets of 1:50,000 scale was used for generation of base layers. In addition IRS-P6 LISS III satellite imageries with spatial resolution of 23.5 m for 1997 and 2007 were used for extracting land use/land cover of the AOI.

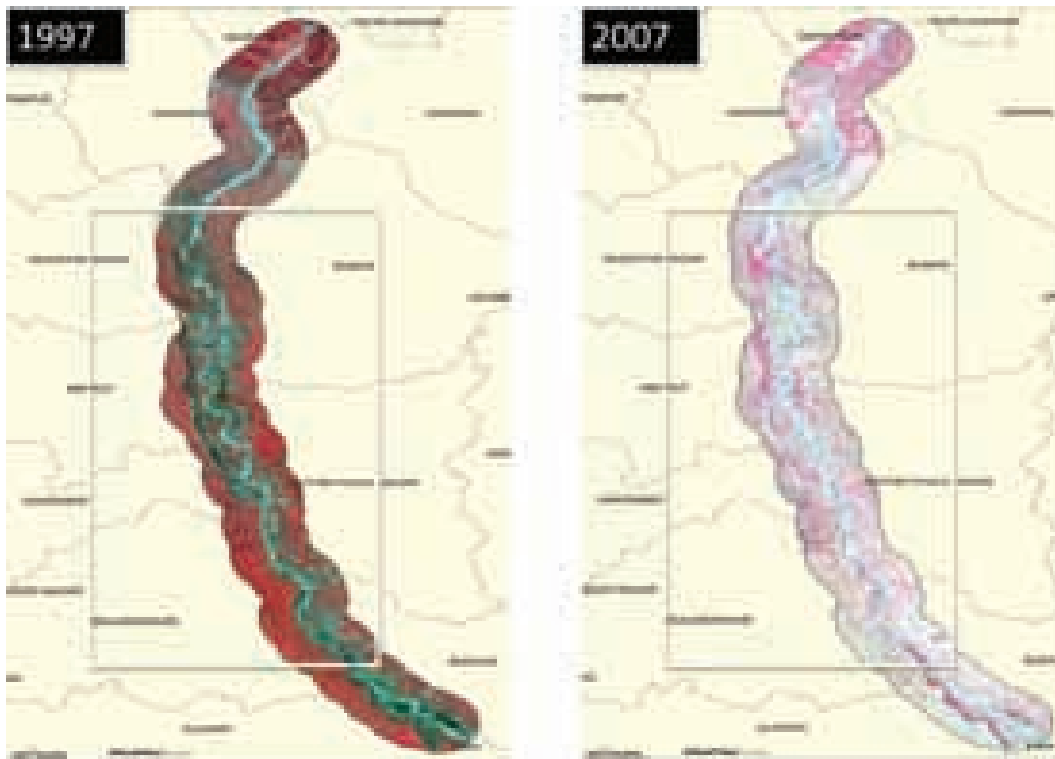
Methodology and Analysis:



Methodology Flow Chart

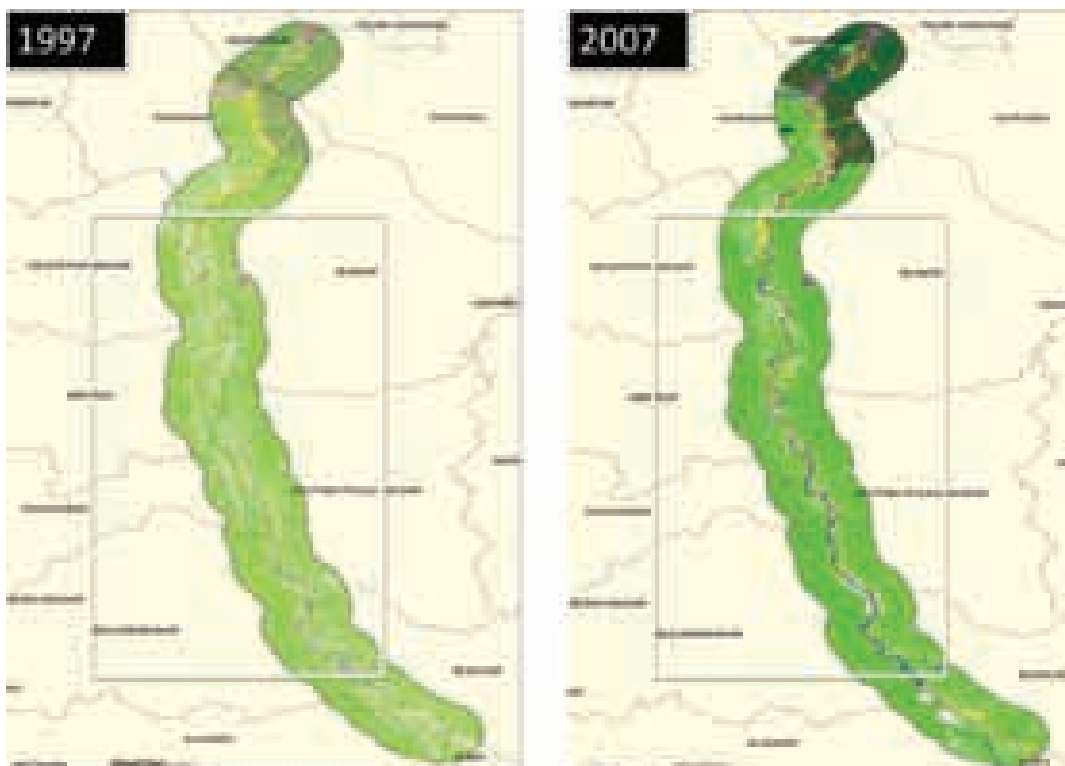
Map -1 (A, B)

Satellite Image showing the status of River Ganga during 1997 and 2007



Map -2 (A, B)

Map showing land use/land cover status during 1997 and 2007



Map -3

Map showing the diversion of Ganga river at different locations

With the help of satellite data and ancillary data, it was found that path of River Ganga has changed to a large extent from 1970s to 1997, and small deviation was also observed during 1997 to 2007. Satellite data of 1997, and ancillary data was showing maximum path difference of 4.6 km and minimum 0.8 km (approximately).



Analysis

Analysis of the both years' satellite data indicates that in 1997 water was spread over an area of about 131.24 sq km (approximately), and in 2007 the water coverage was estimated to be roughly about 158.17 sq km. The analysis indicates increase in water coverage during 2007. This increase of water could be an indication of changing pattern of climate. We know that Ganga river originates from the Gangotri glacier and increase in temperature is slowly leading to melting of the Gangotri glacier, thereby increasing water volume in the river. The increase in water level can also be attributed to other factors like seasonal temperature, rainfall and water consumption from the river.

The points given below could be the reasons behind changes in the path of Ganga river, but detailed study and analysis is needed to correlate it with facts:

1. Geological conditions of that area like fault, fracture etc.;
2. Water velocity of that region;
3. Impact of dams on that area;
4. Forest cover around that area.

Sudden changes in the river path is an indication of change in the velocity of water, which can be a result of increase in water level in the water channel or can be linked to the crustal evolution. Crustal evolution means that due to some tectonic activities crust of the earth has been uplifted in any portion of the river channel due to which sudden changes in the velocity can be observed.

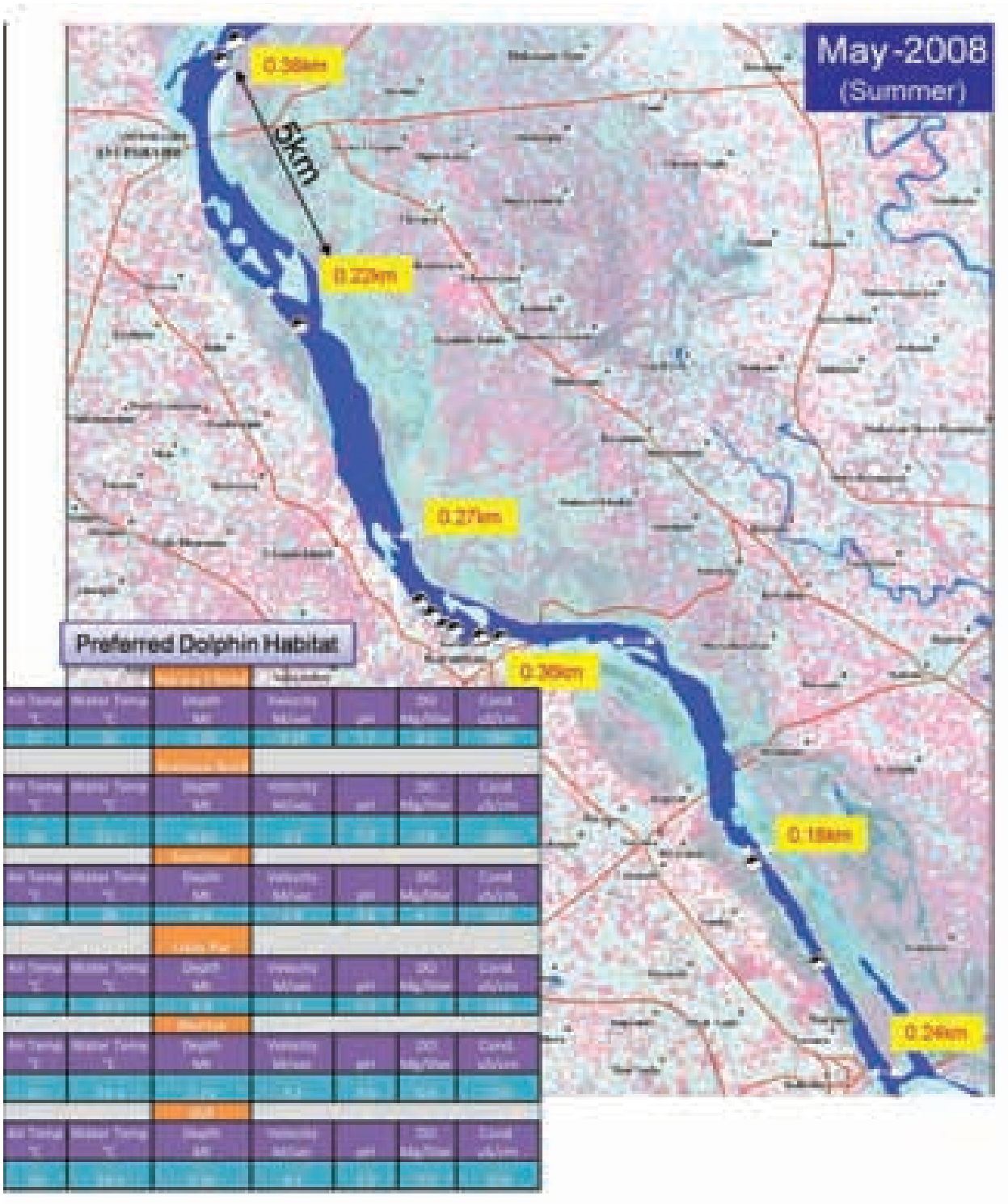
Conclusion

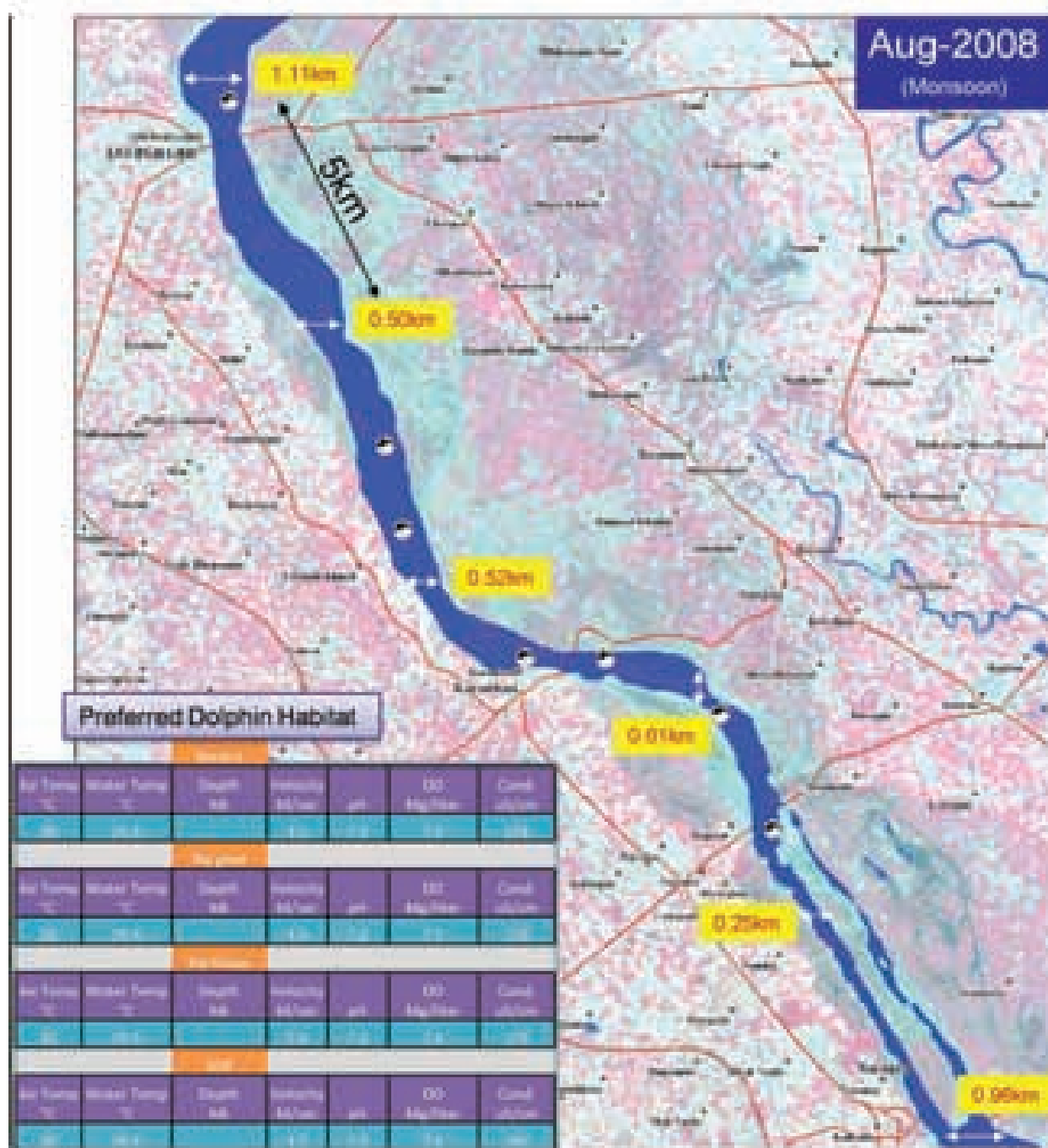
This study was mainly an attempt of integration of two techniques, Remote Sensing and GIS, to study the recent river channel dynamics. The results have been converted into a set of graphical overlay showing the channel pattern change. The study shows that River Ganga has undoubtedly shifted from its path and water is increasing in the water channel of the river.

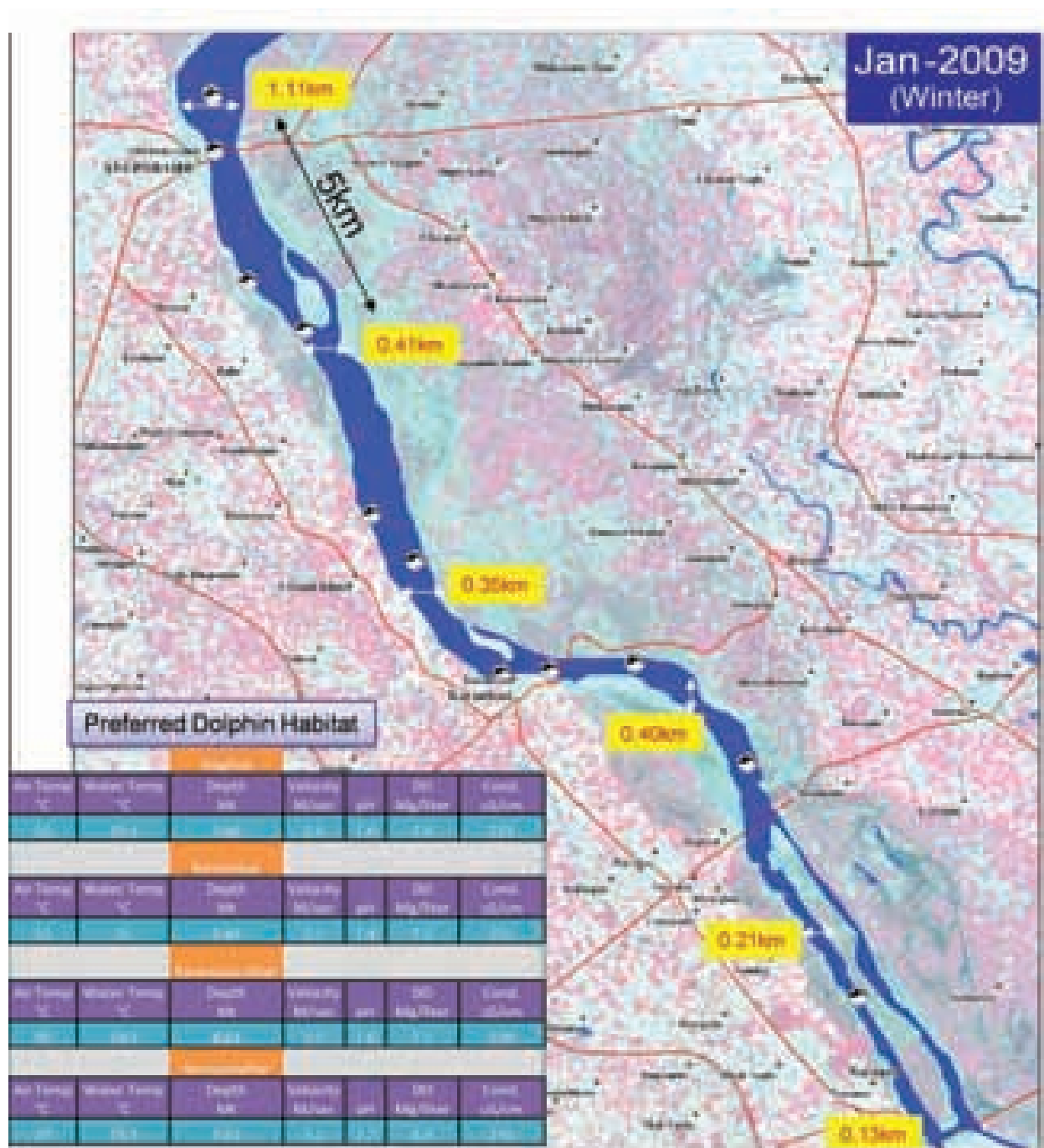
APPENDIX IV

Dolphin Sighting and Habitat utilization in Ganga River (Anupshar to Narora)

The inserted table represents various physical parameters observed at dolphin sighting locations. Physical parameters varies according to the seasons









Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

www.wwfindia.org