Conceptualizing a Wetland Research Agenda for Developing Countries

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Jalaplavit

exploring wetlands

A Special Issue on Wetland Biodiversity Research (with emphasis on Gujarat, India)

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Editorial

Jalaplavit was launched in August 2009 and since then; it has retained two characteristics; a modest bi-annual frequency and 'popular' nature of its articles.

With this December 2013 issue, '*Jalaplavit*' has broken that monotony. How? Well, on one hand this is the third issue in the year 2013 and on the other hand, it is mainly endowed with research papers. So, from now onwards, there will be three issues of '*Jalaplavit'* (instead of two) and the third issue will be a 'Research Special'. '*Jalaplavit*' may also undergo another change in its format. Thus, from 2014, *Jalaplavit*'s usual issues (i.e., the issues that are not 'Research Special') may have both 'popular' articles and 'Research papers' with maximum 50% of manuscripts in the form of research papers.

The Founder Editor is grateful to the other members of *Jalaplavit*'s Core Team for consistent support. **Dr. Jim Anderson,** Senior Technical Adviser of '*Jalalplavit*', who not only worked as a reviewer for a couple of research papers, but also contributed as the first author of a comprehensive article for this issue. The Adviser, **Dr. Pranav Trivedi** also reviewed multiple manuscripts and as the 'Adviser, he has also enriched this issue through his unique contribution "Voice of Wetlands". In his words "I felt the science in this issue can be harmonized by the feelings emanating in the poem"! Thanks are also due to **Dr. Amita Tatu,** Associate Editor for giving 'final touch' to all the manuscripts and compiling all of them in a proper sequence.

Special thanks to **Dr. Hiren Soni**, faculty, Institute of Science & Technology for Advanced Studies (ISTAR), Gujarat who worked as the main external reviewer of '*Jalaplavit*' and reviewed a number of anonymous manuscripts provided to him at short notices. One can get his profile at <https://sites.google.com/site/hirenbsoni/>. **Prof. A. J. Urfi**, Associate Professor, Delhi University, New Delhi also contributed in reviewing select manuscripts and in turn, enriched this issue. The Founder editor gratefully acknowledges his help. The Founder Editor also thank Mr. Kandarp Kathju, Ahmedabad in critically going through a manuscript of his area of interest. Thanks are also due to **Mr. Manoj Dholakia and his team at Pugmark Qmulus Consortium**, Ahmedabad who have contributed the cover design in very short time. And how can one forget to thank all the authors of various papers in this issue! Without their contributions, this issue could not be possible. Though this issue is peer-reviewed by editorial board members and external reviewers, this is the first attempt to publish a 'research oriented' issue and thus, it is very likely that some readers may find that some papers required more work before publication or parts of a paper or two could be published after more research work. But, then, there is no end to perfection-seeking and *Jalaplavit* also believes in encouraging young researchers by providing a platform to them.

The "World Wetlands Day" (WWD)-2014 is approaching fast. There is little over a month left for observing or celebrating it on February 2, 2014. Its official theme released by the Ramsar Bureau is "Wetlands for Agriculture". Through this issue, '*Jalapalvit'* Core Team wishes "Happy New Year" and "Happy World Wetlands Day" in advance..!

-Ketan Tatu

Voice of the Wetland

If I was a wetland,

I would be very disturbed and insecure,

But you wouldn't care, I'm sure,

For reflecting is my nature, from within I'm pure!

Life is my virtue, in diversity I revel,

Each life form inside me - a unique jewel,

Ephemeral in nature,

Just like every creature,

Wealth I do possess in abundance,

Still I'm reduced to such redundance!

Each day my banks shrink, and

Species disappear before you blink,

Plants aplenty and birds in bounty - is how I used to boast,

For hundreds of little creatures – I was the host!

Shimmering water, abounding life... calls of cranes and honking geese

Would you be able to bring back these?

I would if I was a human...alas, that is not the case,

In silence, I watch your destructive ways

You can see - I'm now counting my days;

But you wouldn't care, I'm sure,

For reflecting is my nature, from within I'm pure!

--Pranav Trivedi—

Photo: Pranav Trivedi

Conceptualizing a Wetland Research Agenda for Developing Countries

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ABSTRACT: The purpose of this paper is to briefly identify potential wetland research agendas and topics for developing countries. Every country, and even distinct regions within a country, has its own local issues and those issues should in most cases be prioritized accordingly by researchers within that country. However, some of the common wetland research agenda for developing countries are: wetland classification and inventorying, wetland monitoring, wetland restoration, impact of climate change on wetlands, wetland policies, ecosystem services, public awareness and assessment of economic values of wetlands.

KEY WORDS: Developing Countries, Research, Wetlands,

INTRODUCTION

Wetlands are highly productive ecosystems that are generally characterized by unique soil, vegetative, and hydrologic properties that readily distinguish them from adjacent uplands or deep water aquatic systems (Figure 1). Bogs, fens, swamps, salt marshes, mangroves, marshlands, playas, and moors are just a sample of the many common names by which wetlands are known. This diversity in names is useful for distinguishing various wetland types, but it also complicates the task of defining unified themes for globally-relevant wetland research topics. Due to their high productivity, the numerous ecosystem services they provide, and their propensity to support high biodiversity, wetlands are often the subject of conservation and protection measures and research agendas around the world.

People are often intricately linked to wetland systems. "For many people, wetlands are the window to their soul as wetlands can inspire them with vast populations of wildlife, calm them with their beauty, or teach them about life's little miracles" (Anderson, 2009). Numerous cultures depend on the

ecosystem services that wetlands provide and even communities that do not depend directly on wetlands for their livelihoods receive numerous indirect benefits, which range from cleaner water to solitude and serenity during weekend get-a-ways.

Wetlands cover an estimated five percent to eight percent of the Earth's land area (Mitsch and Gosselink, 2007). We did not readily find an estimate of wetland area in the over 140 countries classified as developing countries (International Statistical Institute 2013), although that number likely exists. However, of the seven million to ten million km^2 of wetlands in the world, it is not difficult to imagine that at least three million to five million km^2 of these wetlands occur in developing countries. There are an estimated 1.72 million km^2 of wetlands identified as "Wetlands of International Importance" in developing countries (Ramsar, 2013). Wetlands of International Importance are selected based on "their international significance in terms of ecology, botany, zoology, limnology or hydrology", with a special emphasis on wetlands of international importance to waterfowl during any season (Ramsar Convention Secretariat, 2013).

The purpose of this paper is to briefly identify potential wetland research agendas and topics for developing countries. We of course realize that every country, and even distinct regions within a country, has its own local issues and those issues should in most cases be prioritized accordingly by researchers within that country. Moreover, not every topic is relevant for a particular region or of the highest importance for every country. However, the items below have long been issues in need of greater study or are emerging themes that need to be addressed. The research priorities are not listed in any particular order as their relevance will vary depending on a country's past research and localized priorities.

RESEARCH PRIORITIES

Wetland Classification and Inventory: It is difficult to make informed decisions and prioritize wetlands for protection or conservation measures without a proper inventory.

Not only should the wetland type and the extent of each wetland type be documented, but the primary plant and animal communities also need to be examined. Once a proper classification and inventory of wetlands has been completed, it is easier to conduct numerous other wetland studies in a less biased manner. A properly conducted wetland inventory is particularly useful for conservation planning efforts (Fuller *et al.,* 1998).

Wetland Monitoring: Wetland monitoring protocols for biological, physical, and chemical parameters need to be established in order to track long-term trends in wetland abundance, condition, and performance (Figure 2). Monitoring can ensure that anthropogenic activities such as agriculture or mosquito control have limited impacts on wetland ecosystem function. If there are significant impacts, then policies and practices can be changed to reduce these impacts. Monitoring also could lead towards the development of wetland indices of biotic integrity (Veselka and Anderson, 2013), functional assessments (Davis *et al.,* 2013), or other more in-depth metrics and assessment protocols.

Constructed Wetlands: Developing techniques and evaluating the efficiency of constructed wetlands for treating various wastewater streams is an area of research still ripe for discovery (Kivaisi, 2001). Understanding the efficiency of various plant species or floating islands in removing pollutants and evaluating various flow-through designs in a variety of climates and flow regimes will help enhance the use of constructed wetlands for wastewater treatment.

Wetland Restoration: Techniques for restoring or creating wetlands to restore wildlife communities, ecological function, and ecological integrity are needed as wetlands are lost as a result of infrastructure development and other activities (Figure 3). In particular, wetlands are often destroyed due to the creation of large reservoirs for hydropower projects. Fringe wetlands and riparian corridors could be restored or created to offset some of these losses. Wetland losses in agricultural areas is also an issue, and techniques for restoration of wetlands in these areas need to be

created and the resulting successor failures need to be monitored.

Impacts of Climate Change on Wetlands: Climate change is of utmost concern to many researchers and policy makers. Effects of climate change on coastal wetland systems are extremely relevant because of the potential for sea-level rise to impact not only mangroves and salt marshes, but also the communities and cultures that live in these coastal regions. There is a critical need for studies that evaluate biodiversity concerns, ecosystem services, and ecotourism associated with wetlands in relation to climate change (Rivera-Monroy *et al.,* 2004).

Ecosystem Services: Developing a better understanding of the services that wetlands provide to people is essential. Ecosystem service provisioning on both undisturbed and disturbed wetlands within various positions on the landscape and various climates is necessary to achieve enhanced wetland protection. Euliss *et al.* (2013) provide a framework for enhancing our understanding of wetland ecosystem services.

Wetland Policies: Wetland policy development and analysis is a continuous wetland research need. Often, we do not view policy as research, particularly as we are writing this from the perspective of natural scientists rather than social scientists, but understanding how wetland policy is created and accepted by politicians and the public is important for developing wetland conservation and protection measures.

Public Awareness: Research on the social values and attitudes of the public towards wetlands needs to be better understood in order to place wetland conservation in the proper context. Most people do not understand or care about wetlands, so developing a better understanding of people's perceptions about wetlands can help guide conservation and management activities (Figure 4).

Determining Economic Values: Studies are needed to determine the economic value of wetlands. We can promote ecological functions all we want, but in many instances, it is still the economics of the situation that will dictate what can and should be done. Thus, projects aimed at increasing our understanding

of the economic values provided by wetlands, or the cost of losing wetlands and having to build artificial structures to compensate for lost ecosystem functions, are necessary for a holistic wetland conservation agenda. Likewise, studies that are designed to understand the relation between people that rely on wetlands for their livelihoods and conservation of those resources are necessary to ensure the long-term survival of both the wetlands and the cultures depending on those wetlands (Béné *et al.,* 2010).

CONCLUSIONS

These are just a few of the many topics that need to be addressed in wetlands research, particularly in developing countries. We hope these suggestions will be useful for researchers seeking ideas or justification for conducting a particular study. This is by no means a comprehensive list of wetland research topics, and again, local researchers and conservationists are most familiar with the research priorities for their area. Informative wetland research of any type is always a welcome addition to the literature.

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Priority Wetland Research Areas

Fig. 1. High elevation (1,300 m) wetland near Lake Abant, Turkey.

Fig. 2. Monitoring winter bird use in wetlands near Efteni Lake, Turkey

Fig. 3. Manipulation of vegetation for regulation of water flow in wetlands near Efteni Lake, Turkey.

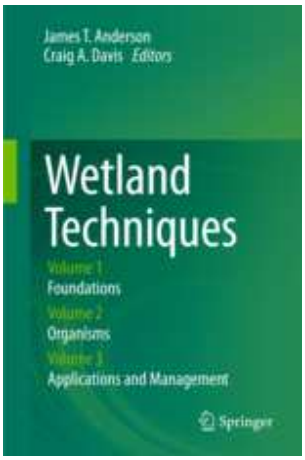
Fig. 4. Domestic waste in wetlands of Efteni Lake, Turkey can be problematic, especially during the winter season.

Introducing A New "Field Technique" Book

Wetland Techniques

by

Dr. James T. Anderson & Dr. Craig Davis (Editors)



A major component of developing strong research protocols is the use and development of appropriate techniques. Many disciplines have developed basic techniques manuals detailing standard protocols and methodologies, but wetland science, still being relatively young does not have such a book, until now. This is where the new three-volume set *Wetland Techniques* can help play a role. The series provides an overview of the various methods that have been used or developed by researchers and practitioners to study, monitor, manage, or create wetlands. The volumes fill a major niche that will be useful for all professionals dealing with wetlands.

Volume-1 provides foundations in the discipline. Volume-2 looks at the organisms that populate wetlands and how to sample and evaluate their populations. Volume-3 examines common applications and techniques in the field. Here is a brief outline of the chapter titles:

Wetland Techniques Volume 1: Foundations

- Study Design and Logistics
- Wetland Bathymetry and Mapping
- Assessing and Measuring Wetland Hydrology
- Hydric Soil Identification Techniques
- Sampling and Analyzing Wetland Vegetation
- Physical and Chemical Monitoring of Wetland Water
- Wetland Biogeochemistry Techniques

Wetland Techniques Volume 2: Organisms

- Methods for Sampling and Analyzing Wetland Algae
- Methods for Sampling and Analyzing Wetland Soil Bacterial Community
- Methods for Sampling and Analyzing Wetland Fungi
- Methods for Sampling and Analyzing Wetland Protoza (Protists)

- Sampling and Processing Aquatic and Terrestrial Invertebrates in Wetlands
- Wetland Fish Monitoring and Assessment
- Wetland Wildlife Monitoring and Assessment

Wetland Techniques Volume 3: Applications and Management

- Wetland Indices of Biological Integrity
- Hydrogeomorphic Classification and Functional Assessment
- Wetland Design and Development
- Management of Wetlands for Wildlife
- Ecosystem Services: Developing Sustainable Management Paradigms Based on Wetland Functions and Processes
- Planning Interpretive and Education Programs for Wetlands

The three-volume set can be obtained as printed copies or as e-books from Springer.

INTER-REGIONAL COMPARISON OF SARUS CRANE POPULATION IN GUJARAT (INDIA) BETWEEN 2001 AND 2010

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ABSTRACT: Gujarat is known to be one of the few stronghold states of India for the globally "Vulnerable" Sarus Crane (*Grus antigone*). GEER Foundation with financial and human resource support of Gujarat State Forest Department and participation of numerous dedicated bird enthusiasts/ members of nature conservation NGOs of the state had organized Statewide Sarus population surveys through total direct count (census) method during the last decade at the interval of three years. Such a long term state-wide effort that was probably unique in the country has not only revealed mean Sarus Crane population in the state during the last decade (2001-2010), but has also enabled region-wise population comparison to decide regions in the state that should get higher priority for Sarus conservation in the state.

KEY WORDS- Central Gujarat, Gujarat, Kachchh, Mean Density, Mean Population, North Gujarat, Region, Sarus Crane, Saurastra, South Gujarat,

INTRODUCTION

Three species of cranes, namely Sarus Crane (*Grus antigone antigone*), Eurasian Crane (*Grus grus*) and Demoiselle Crane (*Anthropoides virgo*) occur in Gujarat, India. Of these, the Sarus Crane is a globally threatened ['Vulnerable'(VU)] crane as per International Union for Conservation of Nature (IUCN)'s Red List of Threatened Species-Version 2013.1. This crane is listed as 'Vulnerable' because it is suspected to have suffered a rapid population decline, which is projected to continue, as a result of widespread reductions in the extent and quality of its wetland habitats, exploitation and the effects of pollutants (BirdLife International, 2013) The Sarus Crane being primarily a wetland species (Sundar, 2009), it is also an indicator of status of wetlands (including flooded rice-fields) in a region. Despite its globally 'Vulnerable' status, Gujarat is among a few stronghold states of India for this Schedule IV [as per Wildlife (Protection) Act, 1972] and a resident crane species of India with only Uttar Pradesh supporting higher Sarus population than that in Gujarat state

(Rahmani, 2012). Owing to the fact that Gujarat is a stronghold state for the resident nominate subspecies of the Sarus Crane (Singh and Tatu, 2000) and because it is a globally 'Vulnerable' bird with declining population trend, Gujarat Ecological Education and Research (GEER) Foundation, with financial and human resource support by Gujarat State Forest Department and active participation of bird watchers, nature enthusiasts and members of the Non-Governmental Organizations (NGOs) of the state had surveyed Sarus population in Gujarat four times in the last decade (i.e. 2001–2010). There is a large band of enthusiastic amateur birdwatchers in the state (Khacher, 2006) and it proved to be the core contributor in all these surveys. The aim of the Sarus population surveys in Gujarat was to determine the population status of the Sarus Crane in the state and its various regions and districts at regular interval (of 3 years) beginning from 2001.

STUDY AREA

Entire Gujarat having 26 districts (during 2001–2010 decade) was covered for the population survey of the Sarus Crane. Gujarat (20° 1' to 24° 7' N and 68°4' to 74°4' E) is the western most state of the country and it is conventionally divided into five regions, namely Kachchh (Kachchh district), Saurashtra (Amreli, Bhavnagar, Jamnagar, Junagadh, Porbandar, Rajkot, Surendranagar districts), North Gujarat (Banaskantha, Gandhinagar, Mahesana, Patan, Sabarkantha districts), Central Gujarat (Ahmedabad, Anand, Dahod, Kheda, Panchmahal, Vadodara districts) and South Gujarat (Bharuch, Dang, Narmada, Navsari, Surat, Tapi, Valsad districts).

MATERIAL AND METHODS

Owing to the vast area to be covered for the surveys and the need of participation of a large number of bird watchers or Sarus enthusiasts and Forest Department personnel, the approach of whole exercise was very important. Thus, before conducting actual surveys, some pre-survey activities were carried out. One of them was a one-day meeting of potential district coordinators, concerned Forest Department officers and GEER Foundation personnel that

was held well in advance of the actual surveys. It was aimed mainly at finalizing and confirming; a) district coordinators (experienced bird watchers or Sarus enthusiasts), b) survey area distribution among them and c) data-sheet based on the draft prepared by GEER Foundation. To coordinate, orient and educate forest department staff and other participants (volunteers), a Satellite Communication (SATCOM) programme was conducted in which participants in different districts received guidance and suggestions about methodology, data-sheet use, identification of adult and immature individuals, time of counts and other details from the senior officers of GEER Foundation and Gujarat Forest Department and invited experts. The GEER Foundation prepared and distributed a Sarus Information Booklet in vernacular language to impart important information to the participants regarding the Sarus Crane in Gujarat. The district coordinators carried out the tasks like field-level survey planning in their respective districts, guidance to novice volunteers, and distributing the datasheets among team members.

Actual surveys were carried out throughout the state in the months of May or June of the years 2001, 2004, 2007 and 2010. The reason for conducting the Sarus population survey in the pre-monsoon period was that this being mainly the pre-breeding season of the Sarus Crane in the state, the individuals often occur in congregations of varying sizes at larger wetlands and thus the possibility of missing them in the counting procedure would be minimized. Data collection through population surveys was carried out for all the districts in all the five regions of Gujarat. In each district, the district coordinator along with selected team members focused on visiting the "key habitats' or 'key sites' for two pre-decided consecutive week-end days that were common for the entire state. Direct Total Count method was adopted for population estimation of the Sarus Crane during all the surveys. Forest Department's front-level staff also covered likely sites as per the directions of their respective senior officers. As the district-coordinators worked in coordination with forest department officers in their respective districts, there was no duplication of

the Sarus count. To estimate Sarus population, both adults and immature birds were taken into account while counting. Researchers from GEER Foundation not only maintained networking with the district-coordinators, but also participated in the surveys wherever needed. The collected data were filled in the data-sheets developed by GEER Foundation with the support of some Forest Department officials and leading senior bird enthusiasts who attended the pre-survey meeting. GEER Foundation attempted to keep variation in efforts for these four surveys (in terms of number of the experienced bird-watchers participating, the quality of observations and survey area covered) as far as possible. Moreover, Gujarat is lucky to have keen scientists and amateurs pursuing the fate of the magnificent bird (Khacher 2006). However, some variation might have crept in inadvertently as there is lack of nationally standardized strategy and criteria for surveying Sarus Crane that widely occurs outside Protected Areas in multiple states of the country. However, to minimize the effect of any likely year-to-year variations in efforts, GEER Foundation has emphasized presenting average population for the entire decade at state and region levels.

RESULTS AND DISCUSSION

Population status of Indian Sarus Crane in entire state and its main five regions (from 2001 to 2010 is shown in Table 1.

Mean Sarus population in Gujarat state during the decade 2001–2010 was 1,649 individuals and mean Sarus density (with respect to the total geographic area of the state in terms of individuals/100 sq. km) was 0.84 individuals/100 sq. km. Investigation into the mean Sarus population at regional level between 2001 and 2010 has revealed that it was highest during the decade in the Central Gujarat region [i.e., 1,232±226.5 (mean±1 SD)]. It consisted of the Sarus population in Ahmedabad (481±67.7), Kheda-Anand (598±208.7), Vadodara (39±25.3), Panchmahals (83±55.6) and Dahod (31±27.7) districts. Density of Sarus with respect to the total geographic area of the Central Gujarat region had also been the highest (i.e., 4±0.8). Kachchh region with the single district

Kachchh had been the region with the lowest mean Sarus population (i.e., 6±5.7) and it had negligible Sarus density too(Table 1). Among other regions, mean Sarus population for the 2001-2010 was the highest in North Gujarat (250±147.6). It was followed by the Sarus population in Saurashtra (87±57.8 individuals) and South Gujarat (76±25.4 individuals) regions in that order. Banaskantha (99±88.9) and Sabarkantha (98±71.4) in North Gujarat, Surendranagar (71±53.4) in Saurashtra and Surat (31±25.0) and Navsari (26±20.0) in South Gujarat have been relatively Sarus-rich districts within their respective regions during the last decade (2001–2010).

In arid and semi-arid areas, Sarus Crane shows local and seasonal movement in response to reducing water levels (Rahmani, 2012). In India, perennial wetlands, reservoirs and cultivated areas with good network of irrigation canals lead to seasonal occurrence of Sarus Cranes. In south-east Asia the Sarus migrates several hundred kilometers each year (Rahmani, 2012). Thus, conducting radio telemetry or ringing study might be useful to determine whether or not Sarus Cranes conduct inter-region migration in Gujarat. Moreover, as Sarus populations also occur in the two neighbouring states, i.e., Rajasthan and Madhya Pradesh, a possibility of interstate migration between such states and the border areas falling in the North and Central Gujarat portions can be investigated. This because detailed research on local and seasonal movement of Sarus Crane is still required (Rahmani, 2012).

CONCLUSION AND RECOMMENDATIONS

As a concluding remark it may be stated that mean Sarus population in the State between 2001 and 2010 was 1,649 individuals. Based on the region-wise mean Sarus population between 2001 and 2010, it is recommended that maximum efforts for Sarus conservation should be focused on Central Gujarat region (especially, Kheda-Anand and Ahmedabad districts) followed by North Gujarat region (especially Banaskantha and Sabarkantha districts). Districts of Surendranagar in Saurashtra and Navsari in South Gujarat should also be considered for Sarus conservation in

the Gujarat state. The state-level conservation efforts will be benefited if the protection status of this 'Vulnerable' species is upgraded from Schedule-IV to Schedule-I of the Indian Wildlife (Protection) Act, 1972. There is also a critical need of having a nationally standardized methodology and criteria for conducting surveys of Sarus Crane that widely occurs outside Protected Areas in multiple states. This is necessary, not only to keep the survey method uniform all over the country but also to keep it uniform from year to year in a long term monitoring.

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Table1. Number and density* of the Sarus Crane in Gujarat and its regions-2001 to 2010

Sr. No.	Year / Region	Population of Sarus Crane(with density*, i.e., Individuals/100 sq. km in total geographic area of a region and the state)				Mean population ± SD (Mean Density*±SD)
		2001	2004	2007	2010	
1	North Gujarat	87(0.3)	402(1.3)	167(0.54)	344(1.12)	250±147.6(0.82±0.5)
2	Central Gujarat	1,202(3.7)	1,089(3.4)	1,561(5.0)	1,076(3.4)	1232±226.5(3.9±0.8)
3	South Gujarat	72(0.3)	88(0.4)	101(0.42)	42(0.18)	75.75±25.4(0.33±0.1)
4	Kachchh	4(0.008)	14(0.03)	2(0.004)	2(0.004)	5.5±5.7(0.01±0.0)
5	Saurashtra	15(0.02)	64(0.1)	132(0.2)	135(0.2)	86.5±57.8(0.13±0.1)
6	Total Sarus Population in Gujarat (Sarus density for the state)	1,380(0.7)	1,657(0.84)	1,963(1.00)	1,599(0.8)	1,649±240.5(0.84±0.1)

* In the true ecological sense, in Table 1 and at other relevant places in the text, 'density' refers to the 'crude density' of Sarus Cranes, i.e., number of individuals of the Sarus Crane per unit area (i.e., every 100 sq. km)with respect to the actual geographical area of each region (in Sr. No. 1-5) or the State (in Sr. No. 6).In other words, in this paper, 'density' does not refer to the 'Ecological Density', which means number of individuals of the Sarus Crane per unit area of actual/suitable habitats in regions or the state.

Sarus Crane-A young one with a parent bird at Vaghroli Irrigation Reservoir, Kheda, Gujarat

Occurrence of Phytoplankton at Sacred Palustrine Habitat, Central Gujarat, India

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ABSTRACT: The aim of our study was to represent the phytoplankton composition of Gomti Palustrine Habitat (GPH), Anand District, Central Gujarat, India. Collections of phytoplankton were carried out at three permanent sampling stations at fortnight intervals over one year time period (three consecutive seasons) from June 2012 to May 2013. The phytoplankton population was represented by a total of 52 genera and 64 species bestowed by Bacillariophyceae (29 species), followed by Cholorophyceae (22), Cyanophyceae (11), and Euglenophyceae (2). Of the total 64 species of phytoplankton, 14 species were abundant, 23 were common and 28 were rare. The present paper discusses the population profile of phytoplankton in waters of GPH with suggested conservation and management strategies.

KEY WORDS: Central Gujarat, Freshwater Lentic Ecosystem, Phytoplankton, Sacred Wetland

Abbreviations: GPH (Gomti Palustrine Habitat); V1 (Sampling Station –I); V2 (Sampling Station –II); V3 (Sampling Station –III)

INTRODUCTION

Wetlands are areas saturated with water either permanently or seasonally, such that they take the characteristics of distinct ecosystems which are amongst the most productive-ones in the biosphere. Wetlands receive different inputs from streams (surface run-off), precipitation and overland flow and subsurface water inputs from surface infiltration, organic matter, stream hypothetic zones and ground water. They are important to wetland productivity because they contain markedly different quantities of transported nutrients (Mann and Wetzel, 1995; Stanley and Ward, 1997). Wetlands are acknowledged as ecosystems harbouring high biological diversity which provide rations for millions of people, but in return, face tremendous stress or as a result of anthropogenic activities throughout the world (Gopal and Chauhan, 2001; Gopal *et al*., 2001). As ecosystems, wetlands are highly volatile being particularly vulnerable to environmental fluctuations. Although wetland biodiversity constitutes a

significant portion (15-20%) of the total biodiversity of the Indian Subcontinent (Gopal and Chauhan, 2001), studies on wetland ecosystems are limited (Tsai and Ali, 1997; Gopal and Zutshi, 1998; Gopal and Chauhan, 2001; de Graaf and Marttin, 2003).

A pond is a body of standing water, either natural or man-made, that is usually smaller than a lake. Ponds may arise naturally in floodplains as a part of a river system, or they may be somewhat isolated depressions such as vernal pools and prairie potholes (Clegg, 1986). Usually, they contain shallow water with marshy and aquatic plants and water-dependent animals. The type of life in a pond is generally determined by a combination of factors including water level spanning with hydrological regime, particularly depth and duration of flooding and nutrient levels. Other factors may also be important, including presence or absence of shading by trees, presence or absence of streams, effects of grazing animals and salinity (Keddy, 2010).

Phytoplankton are integral components of freshwater wetlands, significantly contributing towards succession and dynamics of zooplankton and fish (Payne and Knight, 1997). Community structure, dominance and seasonality of phytoplankton in tropical wetlands are highly variable and are functions of nutrient status, water level, morphometry of the underlying substrate and other regional factors (Gopal and Zutshi, 1998; Zohary *et al*., 1998; Agostinho *et al*., 2001). Phytoplankton are primarily the first-line producers, which control the overall biological productivity of an aquatic ecosystem. They not only provide an estimation of standing crop, but also represent more comprehensive biological index of the environmental conditions (Misra *et al*., 2001). Phytoplankton could be used as the indicators of physico-chemical status of any waterbody (Mittal and Sengar, 1991). Many herbivores (mostly zooplanktons) graze upon the phytoplankton; thus passing the stored energy to the subsequent higher trophic levels.These organisms constitute the first and quantitatively the most imperative link in the food-chain representing the main source of oxygen and energy to the higher

trophic level organisms of the aquatic environment (Juliana *et al*., 2012). Hence, the water input may result in habitat homogenization, thus reducing the spatial planktons heterogeneity (David *et al*., 2000), and in order to sustain a prevailing biota such types of aquatic habitats needs urgent restoration approaches (Selego *et al*., 2012). Though, there are more than 3,513 inland freshwater bodies including a good number of temple ponds in North-East Region of India, little work has so far been done on algal diversity (Baruah and Kakati, 2009).

The goal of this paper is to explore the occurrence of phytoplankton species in the freshwater reaches of Gomti Palustrine Habitat, Central Gujarat, India, along with conservation and management strategies for preserving the prevailing and surviving biota of the region.

MATERIAL AND METHODS

Description of Study Area

Gomti Palustrine Habitat (GPH), District Anand, Central Gujarat, India, is located between 22^0 59' N and 72^0 87' E, with an average elevation of 37 meters (~111 feet) above Mean Sea Level (MSL). Temperature ranges from 12^0 C (Winter) to 36^0 C (Summer) (World Weather Online, 2008). This is a freshwater wetland ecosystem. According to 2001 census, the human population of the region is around 10,024 with an average literacy rate of 74% It is the most worshiped holy place of Lord Swaminarayana, and has also become the source of sacredness for the inhabitants from not only Gujarat but from all over India (Fig. 1).

Sampling

Collections of phytoplankton were carried out at three permanent sampling stations at fortnight intervals over one year (three consecutive seasons) of time period from June 2012 to May 2013. Collected samples were procured with plankton nets (mesh size: 25 µm) from the possible euphotic zone, covering each topographical section of the waterbody. The samples were preserved in 4%formalin on-site, and subsequently brought to the laboratory for further identification (APHA, 2012). Phytoplankton samples were then identified with an aid of a light compound binocular microscope

(Almicro), using standard monographs and manuals such as Cyanophyta (Desikachary, 1959), Freshwater Biology (Edmondson, 1963), Chlorococcales (Philipose, 1976), The Algae: A Review (Prescott, 1984), and Indian Freshwater Microalgae (Anand, 1998). All the samples are preserved in plankton laboratory for comparative studies with other samples as a future reference.

The occurrence status of all the taxa were calculated on the basis of a method depicted by Matteucci and Colma (1982), considering the number of samples in which a given taxon occurred in relation to the total number of samples collected. Of the collected samples, plankton exhibited more than 80% existence assigned Abundant (A) status, between 10 to 70% as Common (C) and less than 10% as Rare (R).

RESULTS AND DISCUSSION

The occurrence of phytoplankton in surface waters of Gomti Palustrine Habitat (GPH) was represented by a total of 64 species belongs to 52 Genera and 4 families. Of which, 21 genera (40.38%) were represented by Bacillariophyceae, followed by Chlorophyceae 19 (36.53%), Cyanophyceae 10 (19.23%), and Euglenophyceae 2 (3.84%) (Table 1, Fig. 3). The peak gradient of diversity of phytoplankton was due to high habitat heterogeneity, owing to the occurrence of high magnitude of aquatic macrophytes around the vicinity of the study location GPH, influenced by favouring surface water quality for sustenance of planktons (Soni and Thomas, 2013a; Soni and Thomas, 2013b; Soni *et al*., 2013, *in press*).

The dominance of phytoplankton was reflected by the occurrence of members of family Bacillariophyceae 29 species (43.75%), followed by 22 species (37.5%) of Chlorophyceae, 11 species (14.58%) of Cyanophyceae, and only 2 species (4.16%) of Euglenophyceae. These results clearly depict the importance and dominance of Bacillariophyceae and Chlorophyceae in the aquatic ecosystem of GPH. Planktons can vary widely in space and time because of the plethora of niches exhibited by such ecosystems (Hillman, 1986). The results obtained in the present study are in congruence with the findings of Soni and Thomas (2013, *in press*) at

Dakor Sacred Wetland, Central Gujarat, India.

Among the recorded species (29), the most abundant species belonging to the family Bacillariophyceae, represented by *Nitzschia amphibia* Grunow, *Navicula sp.*, *Syndrea ulna* (Nitzsch) Ehrenberg, *Cyclotella meneghiniana* Kutzing, *Gomphonemaherculeanum* Ehrenberg, *Navicula rhynchocephala* Kutzing and *Spirogyra* sp.; exhibited their occurrence throughout the study period in waters of all sampling stations, whereas the common species recorded were *Melosira granulata* (Ehrenberg) Ralfs, *Gomphonema parvulum* Kutzing, *Nitzschia sigmoidea* (Nitzsch) W.Smith, *Nitzschia palea* (Kutzing) W.Smith, *Gomphonema sphaerophorum* Ehrenberg, *Navicula radiosa* Kutzing and *Caloneis amphisbaena* (Bory); while the other species of the same family were listed rarely. The dominance of Bacillariophycean members amongst phytoplankton substantiates the previous work of Zutshi, 1991.

Of the reported families, Chlorophyceae formed the second most dominant group of phytoplankton represented by 22 species. Amongst the recorded species, the dominant taxa were *Closterium tunidium, Eudorina* sp., and *Chlorella vulgaris* Beyerinck. On the contrary, species such as *Korshikoviella limnetica* (Lemmermann) P.C.Silva, *Trebauria triappendiculata, Coelastrum microporum* Nageli, *Uronema elongatum* Hodgetts, *Raphidonema sempervirens* Chodat, *Schizogonium murale* Kutzing, *Selenastrum westii* G.M. Smith, *Ankistrodesmus convolutus* Corda, *Ankistrodesmus falcatus var. radiatus* (Chodat) Lemmermann and *Volvox sp.* were observed as common, and the rest of the species were reported as sporadic.

Of the documented species (11) of Cyanophyceae, *Microcystis aeruginosa* Kutzing, *Oscillatoria subbrevis* Schmidle, *Oscillatoria perornata* Skuja, and *Spirulina meneghiniana* Zanardiniex Gomont dominated the other members of the family. *Merismopedia sp.* Meyen was the only species found as rare, while the rest of the species were common. In contrast, family Euglenophyceae was

represented by only 2 species *viz. Phacus longicauda* Ehrenberg Dujardin and *Euglena viridis* Ehrenberg, which could be a resultant impact of a considerable degree of pollution at GPH. These findings are well substantiated with earlier work of Soni *et al*., 2013, *in press*).

The reported taxa (52 genera, 64 species) of phytoplankton at GPH can be depicted by a ratio 1:13:16 (Family: Genera: Species). Table 1 noticeably indicates remarkably the peak species richness (21 Genera, 29 Species) of phytoplankton belonging to family Bacillariophyceae, with a ratio 1:38 (Genera: Species), followed by Chlorophyceae members (19 Genera, 22 Species) with a Genera: Species ratio (1:15). Besides, family Cyanophyceae was ruled with 10 genera and 11 species (Genera: Species ratio - 1:10), while least recorded taxa were represented by members of family Euglenophyceae with only 2 genera and two species each (Genera: Species ratio - 1:1).

Table 2 accounts for site-wise description of all the reported families, genera and species of phytoplankton along with their status at GPH. Site V2 showed the existence of all the documented families (4). Highest occurrence of genera (52) of phytoplankton was recorded in water of Site V2, while 51 genera of phytoplankton each were reported at Site V1 and V3, respectively. Similarly, in congruence with the observed genera, the maximum number of species (64) was observed at Site V2, whereas sites V1 and V3 were found to harbor 63 species each. With respect to the status, 14 species of phytoplankton were found abundant in the water of all the sampling stations, whereas 18 species were classified as common at Site V1, following 17 at Site V3 and the least 12 at Site V2. During the study period, some species of phytoplankton appeared only during one or two months and thus were categorized as rare species. Highest number 13 of such rare species was documented at Site V2, followed by Site V3 (10) and the least at Site V1 (5).

The present investigation clearly revealed that in total 52 genera and 64 species were recorded at Gomti Palustrine Habitat (GPH) throughout the tenure of the research work. The ratio of Family: Genera: Species

revealed that for each family, 13 genera and 16 species of phytoplankton were present. Among the recorded families, family Bacillariophyceae occurred as the most dominant family, accounting for 40.38%, followed by Chlorophyceae (36.53%), Cyanophyceae (19.23%) and Euglenophyceae with the least (3.84%)(Table 1). The site-wise approach at GPH showed the prolific occurrence of all four families of phytoplankton at Sites 2, whereas Site 1 and 3 were recorded with only three families. The peak gradient of phytoplankton species was observed at Site 2 reflected by the existence of members of family Bacillariophyceae and Chlorophyceae. On the contrary, members of family Euglenophyceae (Pollution Indicator) were noted in the water of Sites 2, whereas Site 1 and 3 was devoid of any species of Euglenophyceae. Moreover, the water of Site 1 was dominated by Bacillariophyceaen taxa throughout the study period (Table 2, Annexure 1).

CONCLUSION

The problem that is posed by the blooming phytoplankton is essentially due to the possibility for a number of species to coexist in a relatively isotropic or unstructured environment, all competing for the same sorts of materials, especially when the habitat is impacted by anthropogenic pressures. Looking into its future perception, there is the need to manage, conserve and restore the ecosystem in a proper, well-monitored way.

Different conservation and management strategies to be adopted to maintain the vitality of the waterbody are:

- to improve spawning and rearing of available fish diversity to form an interlinking chain among higher level consumers in trophic pyramids for sustainable networking of food-chains and food-webs;
- to increase the nutrient status and food availability to the prevailing biota therein;
- to restore and enhance the habitat for providing a flourishing niche to wildlife and plant species;
- to curtail the occurrence of toxic contaminants invading the ecosystem by reducing the anthropogenic activities;

- to control the superfluous invasion of non-native aquatic plant species for an equal share of aquatic food resources;
- to lessen the adverse effects of commercial and recreational activities to enhance the richness in biotic diversity; and
- To identify the nutrient sources and understand their broad ecological effects on the ecosystem.

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Table 1. Phytoplanktons recorded at GPH

Family	Genera	Species	G:S
Cholorophyceae	19	22	1.15
Cyanophyceae	10	11	1.10
Bacillariophyceae	21	29	1.38
Euglenophyceae	2	2	1.10
Total (4 Families)	**52**	**64**	**1:13:16** **(Family: Genera: Species)**

Table 2. Status of Phytoplanktons at Sampling Stations (GPH)

Description	V1	V2	V3	Total
A	14	14	14	14
C	18	12	17	23
R	5	13	10	28

* V1, V2, V3: Sampling Stations; A: Abundant, C: Common, R: Rare

Fig. 1. A synoptic view of Gomti Palustrine Habitat (GPH), Central Gujarat, India with Sampling Stations (Source: Google)

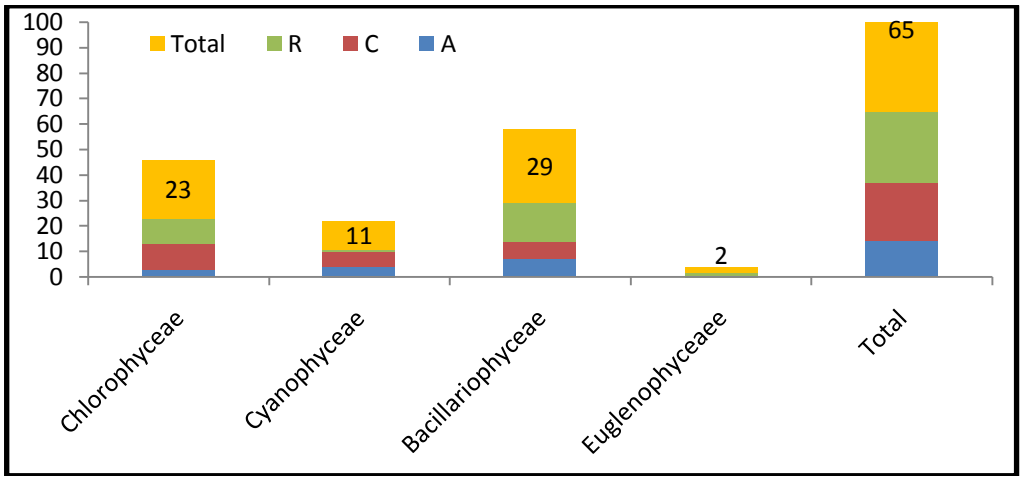

Fig. 2. Occurrence and Status of Families of Phytoplankton at GPH

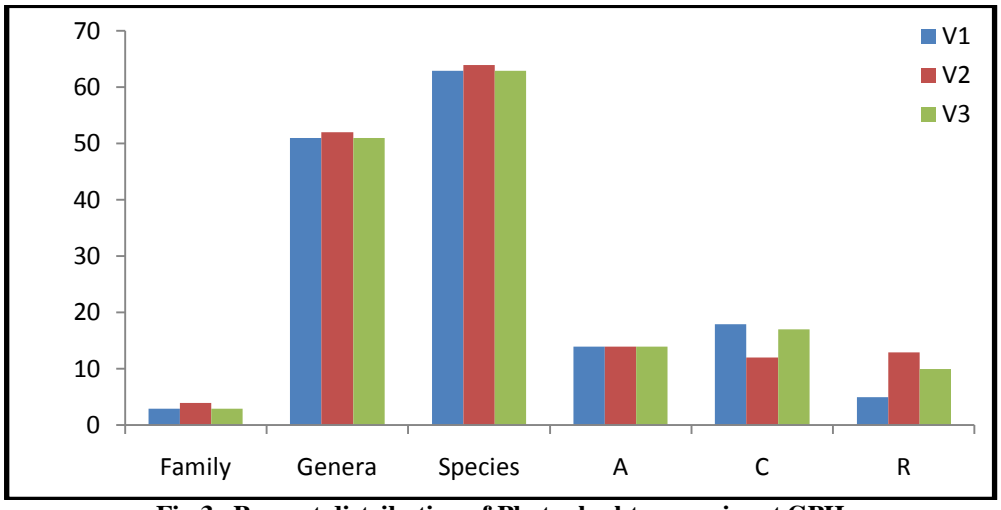

Fig 3. Percent distribution of Phytoplankton species at GPH

Annexure 1. List of Phytoplankton of Gomti Palustrine Habitat (GPH), Central Gujarat, India (June 2012 to May 2013)

Family	Species	V1	V2	V3	Status
Cholorophyceae	*Ankistrodesmusconvolutus* Corda	+	+		C
	Ankistrodesmusfalcatus var. radiatus (Chodat) Lemmermann		+	+	C
	Botryococcusprotuberans West & G.S. West		+		R
	*Chlorella vulgaris*Beyerinck	+	+	+	A
	Cladophoraglomerata (Linnaeus)Kutzing			+	R
	Closteriopsislongissima (Lemmermann) Lemmermann	+			R
	Closteriumtunidium	+	+	+	A
	*Coelastrummicroporum*Nageli	+	+		C
	Eudorina sp.	+	+	+	A
	Korshikoviellalimnetica(Lemmermann) P.C. Silva	+		+	C
	Raphidonemasempervirens Chodat	+		+	C
	Rhizocloniumhieroglyphicum(C.Agardh) Kutzing			+	R
	*Scenedesmusbernardii*G.M.Smith		+		R
	Scenedesmusbifidis		+		R
	*Scenedesmusbijugatus var. disciformis*Chodat		+		R
	Scenedesmusquadricauda (Turpin) Brebisson		+		R
	*Schizogoniummurale*Kützing	+		+	C
	*Selenastrumwestii*G.M.Smith		+	+	C
	Spirotaeniacondensata Brebisson		+		R
	Tetraedronvictorieae var. major Smith			+	R
	Trebauriatriappendiculata	+	+		C
	*Uronemaelongatum*Hodgetts		+	+	C
	Volvox sp.	+		+	C
	Species	**11**	**15**	**13**	
Cyanophyceae	*Anabaena variabilis*	+		+	C
	Chroococcustenax (Kirchner)	+		+	C
	Dactylococcopsisrhaphidioides f. subtortuosa Printz	+	+		C
	Gleocaspasp.	+		+	C
	Merismopedia sp. Meyen		+		R
	*Microcystisaeruginosa*Kutzing	+	+	+	A
	Oscillatoriaperornata Skuja	+	+	+	A
	*Oscillatoriasubbrevis*Schmidle	+	+	+	A
	*Spirulinameneghiniana*Zanardini ex Gomont	+	+	+	A
	Synechococcuselongatus Nagel	+		+	C
	*Synechocystiscrassa*Voronichin	+	+		C

	Species	10	7	8	
Bacillariophyceae	*Bacillaria paradoxa* J.F.Gmelin			+	R
	Caloneis amphisbaena (Bory)	+		+	C
	Chaetoceros Ehrenberg		+		R
	CyclotellameneghinianaKutzing	+	+	+	A
	Cymbellacymbiformis C.Agardh		+		R
	Didymospheniageminata (Lyngbye) M.Schmidt			+	R
	Eunotiapectinalis (Kutzing) Rabenhorst	+			R
	Fragilariacapucina Desmazieres	+			R
	Gomphonemaherculeanum Ehrenberg	+	+	+	A
	Gomphonemaparvulum(Kutzing) Kutzing	+		+	C
	Gomphonemasphaerophorum Ehrenberg		+	+	C
	Gyrosigmaattenuatum (Kutzing) Cleve			+	R
	Melosiragranulata (Ehrenberg) Ralfs	+	+		C
	Meridioncirculare var. constrictum (Ralfs) Van Heurck	+			R
	Navicularadiosa Kutzing	+		+	C
	*Navicularhynchocephala*Kutzing	+	+	+	A
	Naviculasp.	+	+	+	A
	Nitzschiaamphibia Grunow	+	+	+	A
	Nitzschiapalea (Kutzing) W.Smith		+	+	C
	Nitzschiasigmoidea (Nitzsch) W.Smith	+		+	C
	Pinnularia sp.			+	R
	Rhoicospheniacurvata (Kutzing) Grunow			+	R
	Rhopalodiagibba (Ehrenberg) Otto Muller			+	R
	Spirogyrasp.	+	+	+	A
	Stauroneisphoenicenteron (Nitzsch) Ehrenberg	+			R
	Stephanodiscusniagarae Ehrenberg		+		R
	Syndrea ulna (Nitzsch) Ehrenberg	+	+	+	A
	Tabellariafenestrata (Lyngbye) Kutzing			+	R
	Tabellariaflocculosa (Roth) Kutzing		+		R
	Species	**16**	**14**	**20**	
Euglenophyceae	*Euglena viridis Ehrenberg*		+		R
	Phacuslongicauda Ehrenberg Dujardin		+		R
	Species	**0**	**2**	**0**	
	Total Species	**37**	**38**	**41**	

* V1, V2, V3: Sampling Stations; A: Abundant, C: Common, R: Rare

Avian Diversity of Some Reservoirs Associated with Dams in Panchmahal and Dahod Districts, Gujarat (India)

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ABSTRACT: I surveyed 11 man-made wetlands [water reservoirs of dams] of Dahod and Panchmahal Ditricts for bird surveys from January to March 1996. I recorded total 113 species of birds that belonged to 90 genera and 50 families. Of these, 54 species were aquatic and other 59 species were terrestrial. I recorded the highest number of bird species (i.e., 100 species) belonging to 44 families at Dev Dam, and the lowest number species (i.e., 58 species belonging to 32 families) at Kada Dam. Good number of nests of Indian River Tern (*Sterna aurantia*) and Small Indian Pratincole (*Glareola lactea*) were recorded at few wetlands. Though the study/survey was conducted in late 1990s, it might be important from the view-point of providing a bench-mark avifaunal/wetland information that can be used for having a comparative account of dam/reservoir avifauna of the current or future time-frame.

KEY WORDS: Birds, Dam, Dahod, Gujarat, Panchmahals, Reservoir.

INTRODUCTION

At present, well over 490 species of birds from 76 families are recorded from Gujarat (Tiwari, 2010). This shows the richness and diversity of avifauna of the State. Large portions of the State of Gujarat are well-explored by naturalists and ornithologists (Ali, 1949, 1956; Dharamakumarsinhji, 1956; Grimmett et. al., 1998; Khacher, 1996; Parasharya et. al., 2004; Pittie, 2010). Even though, few forest pockets and landscapes have remained unexplored or inadequately explored, or somehow, certain information on the avifauna of these pockets is still unavailable in the existing ornithological / ecological literature pertaining to the State. One such information gap is regarding the avifauna of the areas of Northern and Eastern Gujarat. In my view, published information is not available on the avifauna of the eastern parts of Gujarat; especially for the two districts *viz*. Dahod and Panchmahals. This is particularly true for the wetland birds (Natrajan & Rahmani, 1997; Trivedi & Soni, 2006). In the present study, data on avian diversity in and around some man-made reservoirs of these two

districts are presented. The data of the late 1990s, though old, have significance from the view-point of its utility as bench-mark data and a similar study in the recent period would find the 1990s data useful for having a comparative account of past and present avifauna.

STUDY AREA

Panchmahals and Dahod Districts are dry and hilly areas harbouring rich tribal population. These two hilly regions are a part of the western-most ends of Vindhyachal Mountains. Geographically, the surveyed districts encompass 3566.5 sq. km and 5299.5 sq. km land area respectively, including two Protected Areas *viz*. Ratanmahal Wildlife Sanctuary and Jambughoda Wildlife Sanctuary. Till date, 15 dams have been constructed in these districts by Water and Irrigation Department, Government of Gujarat, traversing all major rivers (Mahi, Panam, Kali, Kabutri, Hadaf, Goma, Dev and Machhan) flowing through Dahod and Panchmahal districts. The dams are constructed for irrigation and electric power generation (**Figure 1, Table 1**). Most of these dams are constructed on different tributaries of the River Mahi, except Kada and Dev Dams. The Dev Dam is constructed on River Dev (also known as Dhadhar-Vishwamitri) and Kada Dam is a very small and connected to Sukhi Dam Canals, situated on the edge of Jambughoda Wildlife Sanctuary. As all these dams have their associated reservoirs of varying area, some are used by State Fisheries Department for inland fishing practice too.

METHODOLOGY

In all, 11 reservoirs (associated with the dams) located within both districts were opportunistically surveyed to record avifauna occurred during the peak winter period (January to March, 1996). The data were collected during three consecutive months of the year 1996, i.e. from January to March. Though surveys were opportunistically conducted, about 20 days were spent at each dam/reservoir. The birds were observed with the help of a pair of binoculars (8 x 50). All the avian species were identified *in situ* using sight and sound clues and identifications were confirmed using recognized field guides (Ali & Reply,

1983; Rasmussen & Anderton, 2012; Grimmett et. al., 2011; Kazermiczak, 2000), following classification and nomenclature of birds (Manakadan & Pittie, 2001). The information about trapping, hunting and breeding of birds was also collected.

RESULTS AND DISCUSSION

During the study period, total 113 species of birds belonging to 90 genera and 50 families were recorded, of which 54 were primarily aquatic and 59 were primarily terrestrial. Of the total recorded species, 84 (74.33%) were found to be resident, 22 (19.46%) migratory and 7 (6.19%) were resident-breeders with migratory status. Forty (35.39%) species of birds belonging to 30 families were observed at all the dam-sites, including 34 (85%) residential and 6 (15%) migratory species (**Appendix 1**).

The highest number (i.e., 100) of bird species belonging to 44 families was recorded at Dev Dam, and the lowest number (58 species, 32 families) was noted at Kada Dam (**Table 2**). The maximum bird diversity recorded at Dev Dam, could be due to availability of varied habitats in and around waterbody along with peripheral forested habitats interspersed with agricultural and scrub landscapes. On the contrary, the low bird diversity was documented at Kada Dam, which might be owing to fluctuating water level. Kada Dam is a temporary water storage reservoir, watered by Sukhi Dam Canal, and regulated by State Irrigation Department. Such types of conditions affected the prevalent avifauna adversely.

During the present study, few bird species were recorded only at one dam-site. These are Great Crested Grebe (Wanakbori Dam), Osprey and Crested Bunting (Kadana Dam), and Red Crested Pochard (Panam Dam). A good number of geese and flamingoes were recorded at Dev Dam only. As the flocks of both species were distant to the observer flying opposite to the light, the species identity is a sole silhouette assumption. Besides, Indian White-backed Vulture (*Gyps bengalensis*) was also recorded at different study sites. The bird species was common here about 15 years ago compared to the present scenario.

In most reservoirs, the water levels dropped gradually, formed various

islands of different sizes in the waterbody. These islands were found to be used by many migratory and non-migratory birds, not only for their safe roosting during night but also as nesting sites by some ground-nesting birds. During the present investigation, considerable number of nests of some ground nesting waterbirds was observed. These birds were Indian River Tern (*Sterna aurantia*), Small Indian Pratincole (*Glareola lactea*) and Great Stone Plover (*Esacus recurvirostris*) (**Table 3**). Moreover, some local fishermen and tribal communities (*Bhuria* and *Bhil*) were also observed collecting eggs from such nests for food on regular basis.

CONCLUSIONS AND SUGGESTIONS

This short-term avifaunal study at different dam-sites of Panchmahals and Dahod districts shows that the avifauna of these areas is more diversified than the presumed assumptions. There is no doubt that large area of forest land submerged into the water due to the construction of hydro-electric projects, which affects ecology of the area too. Today scientists are against the mega-dam construction projects, but on the other hand dam projects are also important and necessary for the development and welfare of the mankind. Present study indicates that reservoirs of studied districts support a good diversity of birds (113 species), which may support other wildlife too. A long-term comprehensive study on avifaunal diversity and impacts of dams is an urgent need to conserve and manage the prevailing bird diversity of the region.

Following are suggestions for better conservation of avian diversity of these two regions:

1) Academic institutions should conduct a detailed study.

2) State forest department should depute few forest guards during the breeding season of ground-nesting birds.

3) State fishery department should conduct educational awareness programs for fish farmers to create awareness about the conservation of the native wildlife and its importance.

4) State forest department and local NGOs should train local tribes through nature-based campaigns for conservation of ground-nesting birds.

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Table 1
List of Man-made Reservoirs, Dahod and Panchmahals Districts, Gujarat, India

Sr. No.	Dam	River	Area of Reservoir (ha)	Area submerged (ha)				Use of Reservoir
				Forest	Waste-land	Cultivated	Total	
Dahod District								
1	Bhadar	Bhadar	545	308	19	123	450.00	I/F
2	Edal*	Panam Tributary	198	000	40	158.5	198.50	I
3	Kabutari*	Kabutari	233	000	63.7	170	233.70	I/F
4	Kadana	Mahi	16600	7750	000	9258	17008.00	I/F/HP/WS
5	Kali	Kali	800	---	---	---	---	WS
6	Machhannala	Machhan	796	000	159.5	623.5	783.00	I/F
7	PataDungri	Khan	1000	---	---	---	1012.93	I/WS/F
8	Umaria*	Hadaf	236	000	54.85	139.48	193.33	I
Panchmahals District								
9	Dev	Dev	1668	213	128	1525	1868.00	I/F
10	Hadaf	Hadaf	750	8	000	700	708.00	I/F
11	Kada	SukhiCanal	500	---	---	---	---	
12	Karad	Karad	874	---	---	---	867.65	I
13	Panam	Panam	8980	2990	000	5547	8537.00	I/F/PG/WS
14	Wankleshwar*	Bet	283	---	---	---	283.28	I
15	Wanakbari	Mahi	2086	---	---	---	2086.00	I/PG

(* not surveyed; I = Irrigation; F = Fishing; WS = Water Supply; HP = Hydro Power; PG = Power Generation)

Table 2
Bird species recorded at different Man-made Reservoirs of Panchmahals & Dahod Districts, Gujarat

Sr. No.	Name of Dam	No. of Resident Birds	No. of Migratory Birds including Resident Breeders	Total No. of Bird Species (Family)
1	Bhadar	62	07	69 (35)
2	Kadana	63	15	78 (41)
3	Kali	68	16	84 (38)
4	Machhannala	67	19	86 (42)
5	PataDungari	60	10	70 (36)
6	Dev	76	24	100 (44)
7	Hadaf	60	09	69 (34)
8	Kada	52	06	58 (32)
9	Karad	57	10	67 (35)
10	Panam	68	10	78 (37)
11	Wanakbori	64	09	73 (39)

Table 3
Records of nests of Indian River Tern (*Sterna aurantia)*and Small Indian Pratincole(*Glareola lactea*)

Sr. No.	Name of Dam	No. of Nests (Indian River Tern)	No. of Nests (Small Indian Pratincole)
1	Dev Dam*	75	28
2	Kadan Dam**	110	122
3	Machhan Dam	80	--
4	PataDungri Dam	36	--
5	Panam Dam**	24	--

*Area covered (50%); **Area covered (30%)

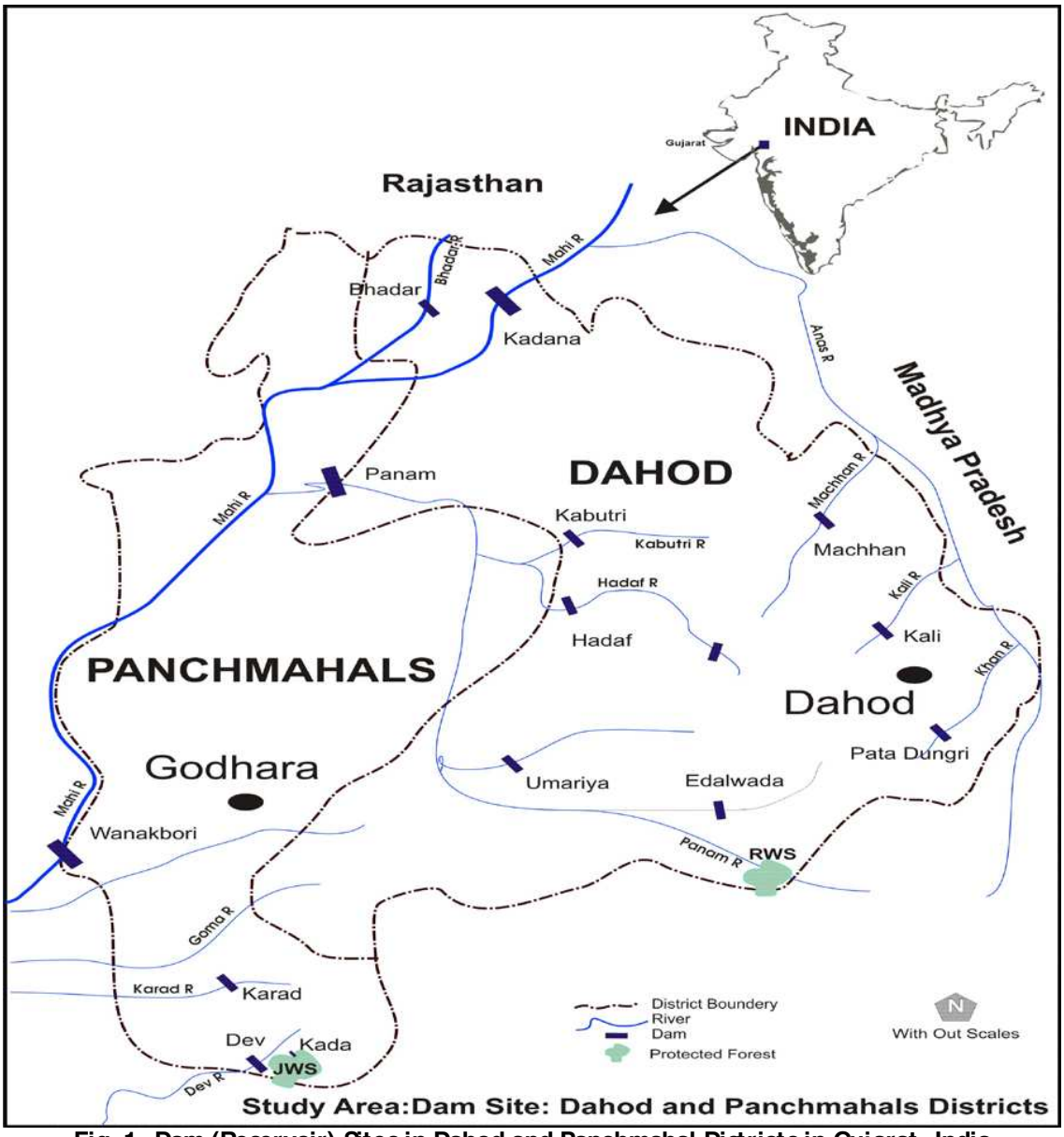

Fig. 1. Dam (Reservoir) Sites in Dahod and Panchmahal Districts in Gujarat, India (RWS: Ratanmahal Wildlife Sanctuary; JWS: Jambughoda Wildlife Sanctuary)

Appendix 1

Birds recorded at Man-made Reservoirs(Dams), Panchmahals and Dahod Districts, Gujarat, India

Sr. No.	Common English Name	Scientific Name	Status	Bhadar	Kadana	Kali	Machhannala	PataDungri	Dev	Hadaf	Kada	Karad	Panam	Wanakbori
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	**PODICIPEDIDAE**													
1	Great Crested Grebe	*Podiceps cristatus*	Ma	A	A	A	A	A	A	A	A	A	A	P
2	Little Grebe	*Tachybaptus ruficollis*	RBa	P	P	P	P	P	P	P	P	P	P	P
II	**PELECANIDE**													
3	Great White Pelican	*Pelecanus onocrotatus*	RB-Ma	A	P	A	P	A	A	A	A	A	A	A
III	**PHALACROCORACIDAE**													
4	Great Cormorant	*Phalacrorax carbo*	RBa	A	P	A	P	A	A	A	A	A	A	A
5	Little Cormorant	*Phalacrorax niger*	RBa	P	P	P	P	A	P	P	P	P	P	P
IV	**ANHINGIDAE**													
6	Darter	*Anhinga melanogaster*	RBa	A	P	A	P	A	A	A	A	A	A	A
V	ARDEIDAE													
7	Grey Heron	*Ardea cinerea*	RBa	P	P	P	P	P	P	P	P	P	P	P
8	Purple Heron	*Ardea purpurea*	RBa	A	A	A	P	A	A	A	A	A	A	A
9	Indian Pond Heron	*Ardea grayii*	RBa	P	P	P	P	P	P	P	P	P	P	P
10	Cattle Egret	*Bubulcus ibis*	RBa	P	P	P	P	P	P	P	P	P	P	P
11	Black-crowned Night Heron	*Nycticorax nycticorax*	RBa	P	P	P	P	P	P	P	P	P	P	P
VI	**CICONIDAE**													
12	Painted Stork	*Mycteria leucocephala*	RBa	A	P	A	P	P	P	A	A	A	A	A
13	Asian Openbill	*Anastomus oscitans*	RBa	A	P	P	P	P	P	A	A	A	P	P
14	European White Stork	*Ciconia ciconia*	Ma	A	A	A	P	A	P	A	A	A	A	A
VII	**THRESKIORNITHIAE**													
15	Oriental White Ibis	*Threskiornis melanocephalus*	RBa	P	P	P	P	P	P	P	A	P	P	P
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
16	Black Ibis	*Pseudibis papillosa*	RBa	P	P	P	P	P	P	P	P	P	P	P
17	Glossy Ibis	*Plegadis falcinellus*	RB-Ma	A	A	P	P	A	P	A	P	A	A	A
18	Eurasian Spoonbill	*Platalea leucorodia*	RB-Ma	P	P	P	P	P	P	P	P	P	P	P
VIII	**PHOENICOPTERIDAE**													
19	(Greater?) Flamingo	*Phoenicopterus sp.*	RB-Ma	A	A	A	A	A	P	A	A	A	A	A
IX	**ANATIDAE**													
20	(?) Goose	*Anser sp.*	Ma	A	A	A	A	A	P	A	A	A	P	A
21	Lesser Whistling Teal	*Dendrocygna javanica*	RBa	P	P	P	P	P	P	P	P	P	P	P

22	Ruddy Shelduck	*Tadorna ferruginea*	Ma	P	P	P	P	P	P	P	P	P	P	P
23	Northern Pintail	*Anas acuta*	Ma	A	A	P	P	A	P	A	A	P	P	A
24	Common Teal	*Anas crecca*	Ma	P	P	P	P	P	P	A	A	A	A	A
25	Spotbilled Duck	*Anas poecilorhyncha*	Ma	A	A	P	P	A	P	A	A	P	P	A
26	Mallard	*Anas platyrhynchos*	Ma	A	A	A	P	A	P	A	A	A	A	A
27	Eurasian Wigeon	*Anas penelope*	Ma	A	A	A	P	A	P	A	A	A	A	A
28	Garganey	*Anas querquedula*	Ma	A	P	P	P	A	P	A	A	A	P	A
29	Northern Shoveller	*Anas clypeata*	Ma	P	P	P	P	P	P	P	A	P	P	A
30	Red-crested Pochard	*Rhodonessa rufina*	Ma	A	A	A	A	A	A	A	A	A	P	A
31	Common Pochard	*Aythya ferina*	Ma	A	A	P	P	A	P	A	A	A	P	A
32	Tufted Pochard	*Aythya fuligula*	Ma	A	P	P	P	P	P	P	A	A	P	A
33	Cotton Teal	*Nettapus coromandelianus*	RBa	A	A	A	A	A	P	A	A	A	P	A
34	Comb Duck	*Sarkidiornis melanotos*	RBa	A	P	P	P	P	P	P	A	A	P	P
X	**ACCIPITRIDAE**													
35	Black shouldered Kite	*Elanus caeruleus*	RBt	P	A	P	P	P	P	P	A	A	A	A
36	Oriental Honey Buzzard	*Pernis ptilorhynchus*	RBt	P	A	P	A	P	A	P	P	A	A	P
37	Pariah Kite	*Milvus migrans*	RBt	P	P	P	A	P	P	P	P	P	P	P
38	Shikra	*Accipiter badius*	RBt	A	A	P	A	A	P	P	P	A	A	P
39	White-eyed Buzzard Eagle	*Butastur teesa*	RBt	A	A	P	A	A	P	P	P	A	A	P
40	Indian White backed Vulture	*Gyps bengalensis*	RBt	P	P	P	P	P	P	P	P	P	P	P
41	Long-billed Vulture	*Gyps indicus*	RBt	A	A	P	A	A	P	A	A	A	A	A
42	Egyptian Vulture	*Neophronpercnopterus*	RBt	P	A	A	A	A	P	P	A	P	A	A
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
43	Western Marsh Harrier	*Circus aeruginosus*	Ma	A	A	A	P	A	P	A	A	A	A	A
XI	**PANDIONIDAE**													
44	Osprey	*Pandion hallaetus*	Ma	A	P	A	A	A	A	A	A	A	A	A
XII	PHASIANIDAE													
45	Gray Partridge	*Francolinus pondicerianus*	RBt	P	P	P	P	P	P	P	P	P	P	P
46	Quail	*Perdicula sp.*	RBt	A	A	A	P	P	P	P	A	A	A	A
47	Indian Pea Fowl	*Pavo cristatus*	RBt	P	P	P	P	P	P	P	P	P	P	P
XIII	**GRUIDAE**													
48	Sarus Crane	*Grus antigone*	RBa	A	A	A	A	A	P	A	A	A	A	P
49	Demoiselle Crane	*Grus virgo*	Ma	A	A	A	P	A	A	A	A	A	A	A
XIV	**RALLIDAE**													
50	White breasted Water-hen	*Amaurornis phoenicurus*	RBa	P	A	P	A	A	P	P	A	A	P	P
51	Common Moorhen	*Gallinula chloropus*	RBa	P	P	P	P	A	P	A	A	P	A	A
52	Purple Moorhen	*Porphyrio porphyrio*	RBa	P	P	P	P	P	P	A	A	P	P	P
53	Common Coot	*Fulica atra*	RB-Ma	P	P	P	P	P	P	P	P	P	P	P
XV	**JACANIDAE**													
54	Pheasant tailed Jacana	*Hydrophasianus chirurgus*	RBa	A	A	P	P	P	P	A	A	A	P	A
55	Bronze winged	*Metopidius indicus*	RBa	A	A	P	A	A	P	A	A	A	P	A

	Jacana													
XVI	RECURVIROSTIRIDE													
56	Black winged Stilt	*Himantopus himantopus*	RBa	P	P	P	P	P	P	P	A	P	P	P
XVII	**BURHINIDAE**													
57	Great Stone Plover	*Esacus recurvirostris*	RBa	A	P	A	A	A	A	A	A	A	A	A
XVIII	**GLAREOLIDAE**													
58	Indian Courser	*Cursorius coromandelicus*	RBt	A	A	A	P	A	A	A	A	A	A	A
59	Collared Pratincole	*Glareola pratincola*	RB-Ma	A	P	A	A	A	P	A	A	A	A	A
60	Small Indian Pratincole	*Glareola lactea*	RB-Ma	A	P	A	A	A	P	A	A	A	A	A
XIX	**CHARADRIIDAE**													
61	Red wattled Lapwing	*Vanellus indicus*	RBa	P	P	P	P	P	P	P	P	P	P	P
62	Yellow wattled Lapwing	*Vanellus malabaricus*	RBa	A	A	A	A	A	P	A	A	P	P	A
63	Little Ringed Plover	*Charadrius dubius*	Ma	P	P	P	P	P	P	P	P	P	P	P
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
XX	**LARIDAE**													
64	Indian River Tern	*Sterna aurantia*	RBa	P	P	P	P	P	P	P	A	P	P	P
XXI	**PTEROLLIDIAE**													
65	Sand Grouse	*Pterocles exustus*	RBt	A	P	A	P	A	A	A	A	P	A	A
XXII	**COLUMBIDAE**													
66	Eurasian Collared Dove	*Streptopelia decaocta*	RBt	P	P	P	P	P	P	P	P	P	P	P
67	Little Brown Dove	*Streptopelia senegalensis*	RBt	P	P	P	P	P	P	P	P	P	P	P
68	Blue Rock Pigeon	*Columba livia*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXIII	**PEITTACIDAE**													
69	Rose-ringed Parakeet	*Psittacula krameri*	RBt	P	P	P	P	P	P	P	P	P	P	P
70	Blossom-headed Parakeet	*Psittacula cyanocephala*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXIV	**CUCULIDAE**													
71	Asian Koel	*Eudynamys scolopacea*	RBt	P	P	P	P	P	P	P	P	P	P	P
72	Crow Pheasant	*Centropus sinensis*	RBt	P	A	P	P	P	P	P	P	P	P	P
XXV	APODIDAE													
73	Asian Palm Swift	*Cypsiurus balasiensis*	RBt	A	P	P	A	P	P	P	P	P	P	A
74	House Swift	*Apus affinis*	RBt	P	P	P	P	P	P	P	A	P	P	P
XXVI	**ALCEDINIDAE**													
75	Lesser Pied Kingfisher	*Ceryle rudis*	RBa	P	P	P	P	P	P	P	P	P	P	P
76	Small blue Kingfisher	*Alcedo atthis*	RBa	P	P	P	P	P	P	P	P	P	P	P
77	White-breasted Kingfisher	*Halcyon smyrnensis*	RBa	P	P	P	P	P	P	P	P	P	P	P
XXVII	**MEROPIDAE**													
78	Small Green Bee-eater	*Merops orientalis*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXVIII	**CORACIIDAE**													

79	Indian Roller	*Coracias benghalensis*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXIX	**UPUPIDAE**													
80	Hoopoe	*Upupa epops*	Mt	A	A	P	A	A	P	A	A	A	A	P
XXX	**CAPITONIDAE**													
81	Coppersmith Barbet	*Megalaima haemacephala*	RBt	P	P	P	P	P	P	P	P	P	P	P
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
XXXI	**ALAUDIDAE**													
82	Ashy crowned Finch Lark	*Eremopterix grisea*	RBt	P	P	P	P	P	P	P	P	P	P	P
83	Crested Lark	*Galerida cristata*	RBt	P	P	P	P	P	P	P	A	P	P	P
84	Short-toed Lark	*Calandrella brachydactyla*	RBt	P	P	P	P	P	P	A	A	P	P	P
XXXII	**HIRUNDINIDAE**													
85	Wire tailed Swallow	*Hirundo smithii*	RBt	P	P	P	A	A	P	A	A	A	P	P
86	Red-rumped Swallow	*Hirundo sp.*	Mt	P	P	P	A	P	P	P	A	P	P	P
XXXIV	**LANIIDAE**													
87	Rufous backed Shrike	*Lanius isabellinus*	RBt	P	P	P	P	P	P	A	A	A	P	A
XXXV	**DICRURIDAE**													
88	Black Drongo	*Dicrurus macrocercus*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXVI	**STURNIDAE**													
89	Brahminy Myna	*Sturnus pagodarum*	RBt	P	P	P	P	P	P	P	P	P	P	P
90	Common Myna	*Acridotheres tristis*	RBt	P	P	P	P	P	P	P	P	P	P	P
91	Bank Myna	*Acridotheres ginginisnus*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXVII	**CROVIDAE**													
92	Indian Tree Pie	*Dendrocitta vagabunda*	RBt	A	A	P	A	P	P	P	P	A	A	P
93	House Crow	*Corvus spllendens*	RBt	P	P	P	P	P	P	P	P	P	P	P
94	Jungle Crow	*Corvus macrorhynchos*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXVIII	**PYCNONOTIDAE**													
95	Red-vented Bulbul	*Pycnonotus cafer*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXIX	**CAMPEPHAGIDAE**													
96	Large Cuckoo Shrike	*Coracina macei*	RBt	A	A	A	A	A	P	A	A	A	A	P
XXXX	**TIMALINAE**													
97	Common Babbler	*Turdoides caudatus*	RBt	P	P	P	P	P	P	P	P	P	P	P
98	Jungle Babbler	*Turdoides striatus*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXXI	**MONARCHINAE**													
99	Tailor Bird	*Orthotomus sutorius*	RBt	A	A	P	A	A	P	A	A	A	A	A
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
XXXXII	**TURDINAE**													
100	Indian Robin	*Saxicoloides fuulicata*	RBt	P	P	P	P	P	P	P	P	P	P	P

101	Oriental Magpie Robin	*Copsychus saularis*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXIII	**PARIDAE**													
102	Great Grey Tit	*Parus major*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXIV	**MOTACILLIDAE**													
103	Grey Wagtail	*Montacilla cinerea*	Ma	P	P	P	P	P	P	P	P	P	P	P
104	Pied Wagtail	*Montacilla maderaspatensis*	RBa	P	P	P	P	P	P	P	P	P	P	P
XXXV	**NECTARINIDAE**													
105	Purple Sunbird	*Nectarinia asiatica*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXVI	**ZOSTEROPIDAE**													
106	Oriental White eye	*Zosterops palpebrosus*	RBt	A	A	A	P	A	P	A	A	A	A	P
XXXVII	**PASSERINAE**													
107	House Sparrow	*Passer domesticus*	RBt	P	P	P	P	P	P	P	P	P	P	P
108	Yellow-throated Sparrow	*Petronia xanthocollis*	RBt	P	A	A	P	A	P	A	A	A	P	P
XXXVIII	**PLOCEIDAE**													
109	Baya Weaver	*Ploceus philippinus*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXIX	**ESTRILDIDAE**													
110	White-throated Munia	*Lonchura malabarica*	RBt	P	P	P	P	P	P	P	P	P	P	P
111	Spotted Munia	*Lonchura punctulata*	RBt	P	P	P	P	P	P	P	P	P	P	P
XXXXX	**EMBERIZIDAE**													
112	(?) Bunting	*Emberiza sp.*	Mt	P	P	P	P	P	P	P	P	P	P	P
113	Crested Bunting	*Melophus lathami*	RBt	A	P	A	A	A	A	A	A	A	A	A
Total species				**69**	**78**	**84**	**86**	**70**	**100**	**69**	**57**	**67**	**78**	**73**

(P: Present; A: Absent; M: Migratory; RB: Resident Breeder; RB-M: Resident Breeder & Migratory, a: Primarily Aquatic, t: Primary Terrestrial)

Status of Scleractinian Corals of Narara Reef in the Gulf of Kachchh, Western India

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ABSTARCT: Corals are considered to be the rain forests of the marine waters as they harbour diverse marine life more than any other ecosystem. Out of four major coral reef ecosystems of India; the state of Gujarat harbours one coral reef ecosystem on the southern coast of the Gulf of Kachchh (GoK). Majority of the coral based studies in the GoK are confined to their taxonomy. The paper describes the overall status of Narara reef in the central parts of the Southern GoK. As the area is declared as National Park and Sanctuary; the study is useful in the direct management action for the conservation. The paper is a part of the Ph.D. dissertation work of the first author.

KEYWORDS: Corals, Gulf of Kachchh, Scleractinian

INTRODUCTION

Distribution of corals in the Gulf of Kachchh (GoK) is confined to its southern shore. To protect these corals, Government of Gujarat declared the area as Marine National Park and Sanctuary (MNP and S) through first notification in 1982 and then several other subsequent notifications at later dates. Total forty two locations (Asari and Jani, 2004) have been identified, which have live coral occurrences. Till date most of the studies of corals and coral ecology of this area were restricted to the taxonomy (Patel, 1985; Pillai and Patel, 1988; Venkatraman, *et al.,* 2003; Satyanarayana, 2009). However, the status of reef building (scleractinian) coral reefs of any specific reef of the MNP and S, has not been documented. Hence reef specific studies were planned and reef-wise scleractinian status including species richness, frequency, other benthic substrates and associated fauna was assessed. The paper represents one of the most popular coastal coral reefs of the GoK *viz*. Narara, situated in the central part of the southern GoK and is a part of Marine National Park and Sanctuary (MNP & S) - Jamnagar.

STUDY AREA

Gulf of Kachchh (The word "Kachchh" is being spelt in many ways, here we adhere to "Kachchh" as indicated by GCRMN and ENVIS publication of CASMB, Balasubramanian and Khan, 2001) is one of the largest coastal habitat in the West coast of India in

the state of Gujarat (20° 15' to 23° 35' N and 60° 05' to 70° 22' E). It is funnel shaped, East – West oriented, seismically active indentation and one of the three macro-tidal regions of India (Chauhan *et al*., 2006). The Gulf of Kachchh (GoK), ~125 km long and 75 km wide (the longest along the northwest coast of India), lies between the mainland of Kachchh in the north and the Saurashtra/ Kathiawar peninsula in the south and is open to the Arabian Sea in the west (Laju *et al*., 2009). The GoK is a relatively shallow basin with the depth extending from ~60 m at mouth to 20 m at neck region (Nair, 2002).

Narara Coastal reef

Geographic Location: 22°25.8' to 22°28.3' N and 69°42.1' to 69°44.7' E

General features: It is a popular nature camps site to study marine fauna and flora.Narara was once considered as an island and hence still pronounced as 'beyt' (*i.e.* an island). Due to the development of salt works and other human activities, it is now well connected with the main land. The intertidal reef area of the site is one of the largest amongst such areas in Gulf of Kachchh. The site has typical intertidal fringing reef that can be divided in to reef flat, reef crest and reef slope. The live corals in the reef were found sparsely at the junction of reef flat and reef slope to the seaward margins of the reef slope. However, the concentration of live corals was observed in some parts of the eastern, very less in the northern and western edges of the reef crest.

MATERIAL AND METHODS

The stratification was done for two major strata *i.e.* upper strata which included reef flat and the lower strata included reef edge and the reef slope. Quadrat of 1 x 1 meter was laid (Krebs 1986) at every 20th meter in a straight line parallel to the reef edge. Total 464 quadrats were laid of which 289 quadrats were laid in the upper strata *i.e.* reef flat area and remaining 175 quadrats were laid on the lower strata *i.e.* reef slope and reef edge. The corals were identified using standard identification keys (Veron, 2000). All the invertebrates including corals were photographed using intova 7 megapixel camera with its underwater housing and identified using standard field guides (Gosliner *et al.,* 2008). Geocoordinates were recorded using Etrex Garmin hand

held GPS navigator. The data analysis was carried out in the following pattern:

The basic analysis such as mean, Standard deviation, average *etc.* was carried out using MS. Excel 2007. Percentages cover of all the benthic community (corals, vegetation and substrate) was calculated. t – Test between the live coral cover of upper strata and lower strata for each location was performed using Prism 3.0 software. Pearson's correlation Index was calculated using Prism 3.0 Frequency of Occurrence for all the species were calculated using the formula: Frequency of Occurrence (*f*) = (occurrence of species *x* in no. of transects / total transects) (Krebs, 1986). Jaccard's Species Index of Similarity was calculated between lower strata and upper strata for coral richness using the following formula (Michael 1986) $Js = J/(a+b-J)$ Where 'J' is number of species common at two sites, 'a' is species richness at one site and 'b' is species richness at second site.

RESULTS AND DISCUSSION

Species Richness

In the upper strata *i.e.* reef flat, live corals occurred in 32% quadrats, while the lower strata 39% quadrats recorded live coral averaging the frequency of occurrence to 36.15% Within the sampled area; 19 species of hard corals were recorded. The Jaccard's species similarity index between the upper and the lower strata was 0.44. Only one species *Parycyathus stokessi* was recorded outside the sampling area, making the total species richness of 20 species.

Benthic substrate Coverage

Seven parameters were recorded for the benthic coverage in the quadrats for both upper and lower strata at Narara.

Live Coral cover: Average live coral cover percentage at Narara was 3.51% The coral cover of the lower strata though low, (4.85%), was significantly different than that of upper strata (2.17%) ($P < 0.01$, df = 463).

Algal cover marginally differed with 33.68% in lower strata and 29.57 % in the upper strata. Rock coverage dominated the lower strata with 43% compared to 34% of the upper strata.

Rubbles were having almost similar coverage 11.1% in the upper strata and 14.4%in the lower strata.

Relative Frequency of occurrence of hard coral species at Narara (Table 5.6 Fig 5.6)

Favia favus, was the most frequently occurring species with relative frequency of 37.8% *Favia specieosa* and two species of *Favites* were found to be frequently occurring species with relative frequency of 17.7, 13.4 and 11.6% respectively. These were followed by *Porites lutea* with relative frequency of 9.8% Seven species *viz. Turbinaria peltata, Goniopora minor, Symphillia recta, Porites hispida, Montipora foliosa, Montipora venosa and Acanthastrea hillae* showed very low occurrence.

In addition to the coral reefs other 51 invertebrate species were recorded during the study. Maximum species richness was observed in Mollusca phylum, followed by Porifera and then Arthropoda.

Total 20 species have been recorded during the present study from Narara. However in the past studies, 6 species were recorded by Pillai and Patel (1988), total 16 species were recorded by Kundu (2001), of which *Meandrina Arabica* and *Flavellum flavum* have not been reported in any of the publications on corals of GoK, and were not recorded during the present study also. Kundu (2001) has also mentioned that the *Meandrina arabica* was dominant on the coast during his study; however the existence of the genus in the coral taxonomy is confirmed but there is no evidence of such species (Veron, 2000). Unfortunately the author has not even claimed it to be the first record of the species from the country also. Veron (2000) has shown occurrence of this genus from Brazil and there exist no earlier record from India. The existence of this species needs species specific investigations. Dave (2001) has given comprehensive account of Narara reef, recording 27 species of hard corals from Narara reef only.

Sedimentation is reported to be a major factor influencing corals and coral communities (Rogers, 1990; Rigel *et al.,* 1995; Done, 2010). The naturally high rates of sedimentation on the upper strata of this fringing reef may have caused considerable

coral mortality. Many corals experienced high sedimentation stress throughout the year due to either the churning pattern of the sea, river and monsoon run offs or occasionally by continuous dredging by the port/jetty authorities to maintain ship traffic. At GoK this is observed especially in the eastern and central part (near the study location, Narara). Subsequently, it is difficult to specify the threshold values of sedimentation, above which anthropogenic causes can be mitigated. Some reviews on the effects of sedimentation on coral reefs suggest severe to catastrophic effects resulting from sedimentation rates of >50 mg/cm^2/d (Rogers, 1990). The coral genera belonging to Favidae and Poritidae are able to withstand strong wave action due to their massive or submassive growth forms and can tolerate high levels of sedimentation (Ayling and Ayling, 1991; Oliver *et al.,* 1999), and which is evidently seen in their frequency of occurrence. The coral groups that are more susceptible to bleaching and wave impacts are *Acropora* and *Pocillopora* corals (Wilkinson, 2008), which are not recorded from these reefs during the present study. The past records of these species are only of dead specimen (skeletal) (Pillai and Rajagopalan, 1979; Pillai and Patel, 1988; Styanarayana, 2009). The reason could be due to the high silting (Pillai and Rajagopalan, 1979).

Species of *Favia* genus *i.e. F. speciosa* and *F. favus* with maximum relative frequency at Narara of 37.8, shows monospecific assemblages indicating greater "*limits of tolerance*" (Shelford's Law of tolerance) of the species. These species which can adapt to a broad spectrum of habitats along with greater limits of tolerance are known as "Generalist species" (Krebs and Davies, 1993). The frequency of remaining species of corals were very low, indicating their low tolerance limits towards the environmental fluctuations. Such species are called Specialised species (Krebs and Davies, 1993). The number of such species is always high in the given habitat (Michael, 1986). The habitats /ecosystems dominated by single genus / species are negative sign of the ecosystem (Bawa *et al.,* 2011).

Tolerance of these generalist coral species of Narara can be attributed to the growth forms and the size of their corallite. The massive, submassive

and encrusting types of growth forms are such in shape that they do not allow sediments to settle on the coral colony (Prasanna, 2008).

CONCLUSION

The history of the Narara reef reveals that even before the area was declared as MPA, the dredging of the reef for sand and other calcium resources were in practice. In the current study also, maximum industrial pressure is noted on the central and eastern parts of the gulf including Narara reef. Considering the coral growth physiology, if such pressure continues for a longer duration, the corals will become restricted to the some generalist species only with retarded growth and lower recruitment rates. The results of the current study clearly indicates heavy degradation at the Narara reef with reference to live coral cover and coral species richness, which points out towards the past exploitation of the reefs of eastern and central gulf area and industrialization, which is also building rapid pace in the eastern and central GoK.

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Table 1: Numerical and statistical Comparison of habitat characteristics and coral community between the upper and lower strata of the reef at Narara

Sr. No.	Parameters	Upper Strata	Lower strata	Total / Average
1	Total quadrats laid	289	175	464
2	Quadrats with presence of Live Coral	95	69	164
3	Frequency of occurrence	32.87	39.43	36.15
4	Species Richness (within the sampled area)	15	11	19
5	Additional species (outside the sampled area)			1
6	Total Species Richness			20
7	Jaccard's Similarity Index Between two strata			0.44
8	Probability value of t - Test of Live corals between two strata			0.0018**
9	Benthic cover of Live Coral (%)	2.17	4.85	3.51
10	Benthic cover of Algae (%)	29.57	33.68	31.625
11	Benthic cover of Mud (%)	4.6	1.1	2.85
12	Benthic cover of Sand (%)	17	2.4	9.7
13	Benthic cover of Rock (%)	34	43	38.5
14	Benthic cover of Rubble (%)	11.1	14.4	12.75
15	Benthic cover of Other fauna (%)	1	1.03	1.015

** Highly Significant

Table 2: Associated invertebrates recorded during the study

	Porifera
1	*Haliclona sp.*
2	*Calyspongia sp.*
3	*Suberites sp.*
4	*Haliclona implexiformis*
5	*Galiodes sp.*
6	*Cinachyrella alloclada*
7	*Cinachyra sp*
8	*Cliona delitrix*
9	*Sigmadocia caerulea*
	Cnidaria
10	*Palythoa sp.*
11	*Porpita porpita*
12	*Heteractis sp.*
13	*Stichodactyla gigantean*
14	*Stichodactyla haddoni*
	Arthropoda
15	*Portunus pelagicus*
16	*Pilumnus vespertilio*
17	*Phalangipus hystrix*
18	*Periclimenes brevicarpalis*
19	*Eucine australis*
20	*Pherecardia striata*
	Mollusca
21	*Trochus niloticus*
22	*Lunella coronate*
23	*Cerithidea cingulate*
24	*Telescopium telescopium*
25	*Natica picta*
26	*Bursa granularis*
27	*Bufonaria spinosa*
28	*Murex ternispina*
29	*Nassarius olivacea*
30	*Cardium flavum*
31	*Pinna bicolor*
32	*Scutus unguis*
33	*Octopus vulgaris*
34	*Erronea onyx*
35	*Berthellina citrina*
36	*Elysia tomentosa*

37	*Hypselodoris sagamiensis*
38	*Joruna funebris*
39	*Peltodoris murrea*
40	*Atagema spongiosa*
41	*Atagema alba*
42	*Sclerodoris tuberculata*
43	*Dendrodoris fumata*
44	*Dermatobranchus fortunate*
45	*Onchidium verruculatum*

	Echinodermata
46	*Ophioplocus imbricatus*
47	*Salmacis bicolor*
	Helminthes and other Worms
48	*Acanthobonellia pirotanensis*
49	*Maritigrella fuscopunctata*
50	*Pseudobiceros hancockanus*
51	*Sabellastarie indica*

Table: 3: Comparison of Species Richness of Narara reef between the Study of Pillai and Patel (1988) and Current study

Sr. No.	Scientific Name	IUCN Status	**Present Study**	**Pillai & Patel 1988**
1	*Acanthastrea hillae*	NT	*	-
2	*Cyphastrea seralia*	LC	*	*
3	*Favia speciosa*	LC	*	-
4	*Favia favus*	LC	*	*
5	*Favites sp1.*		*	-
6	*Favites sp2.*		*	-
7	*Goniopora minor*	NT	*	-
8	*Goniastrea pectinata*	LC	*	*
9	*Leptastrea purpuria*	LC	*	-
10	*Montiopora venosa*	NT	*	-
11	*Montipora explanata*		-	*
12	*Montipora foliosa*	NT	*	-
13	*Platygyra sinensis*	LC	*	-
14	*Porites lutea*	LC	*	-
15	*Porites solida*	LC	*	-
16	*Porites hipsida*	LC	*	-
17	*Pseudosiderestrea tayami*	NT	*	*
18	*Siderestrea savigyna*	LC	*	-
19	*Symphillia recta*	LC	*	-
20	*Turbinaria peltata*	VU	*	*
21	*Paracyathus stockessi*	DD	*	-
	Present in Pillai and absent in current study		1	
	Present in current study absent in Pillai's study		15	
	Present in both studies		5	

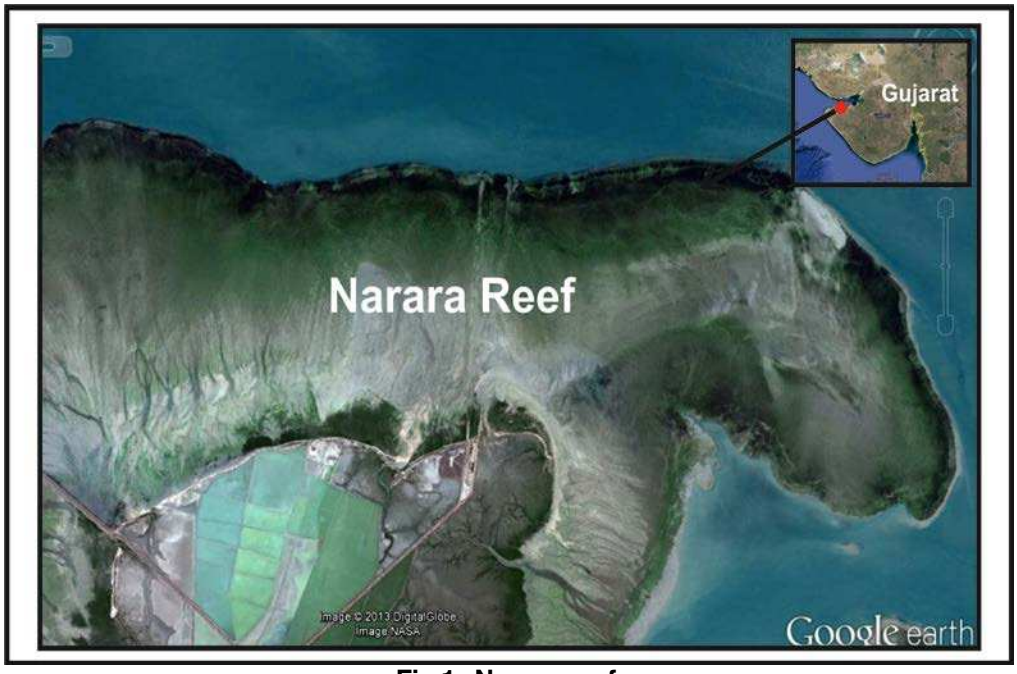

Fig 1: Narara reef

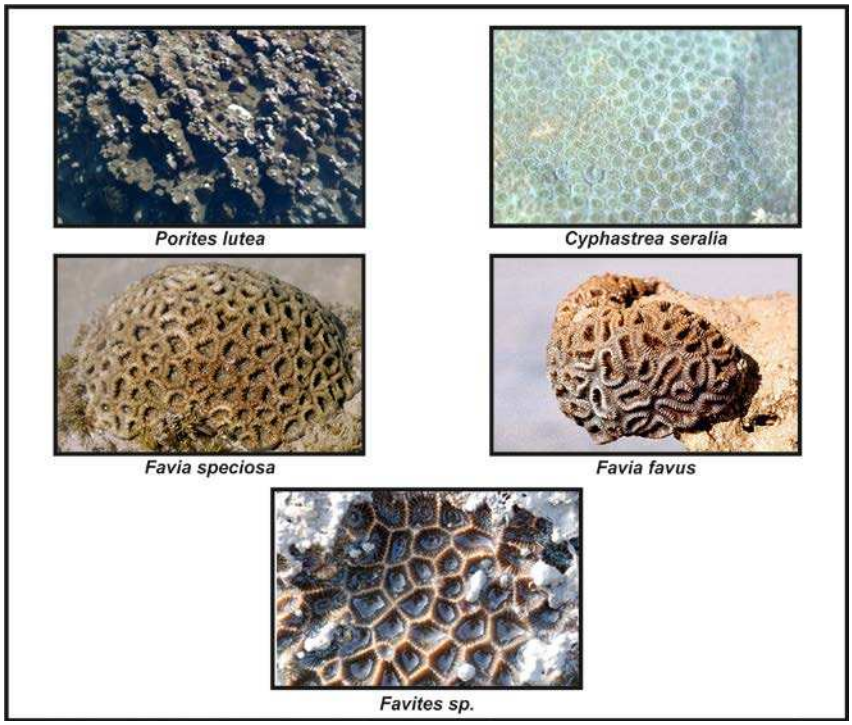

Fig 2: Important corals of the GoK

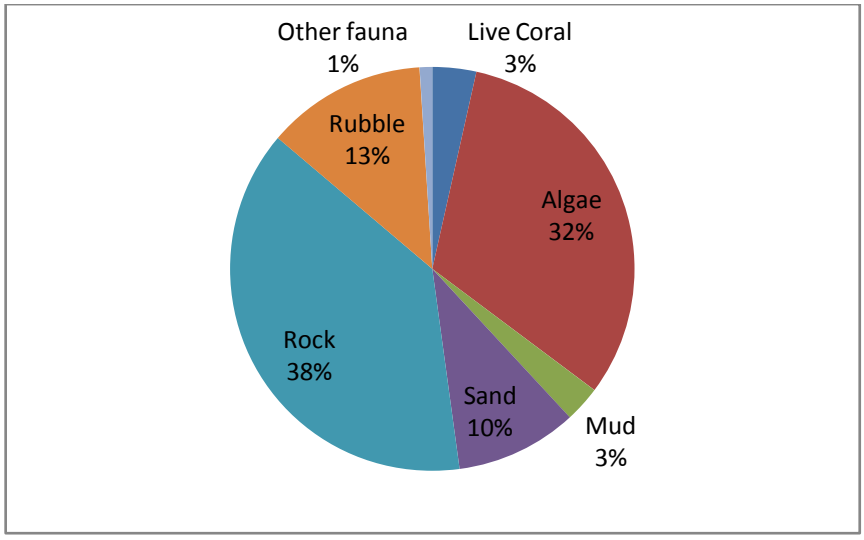

Fig 3: Cumulative benthic Cover (%) of Narara Reef

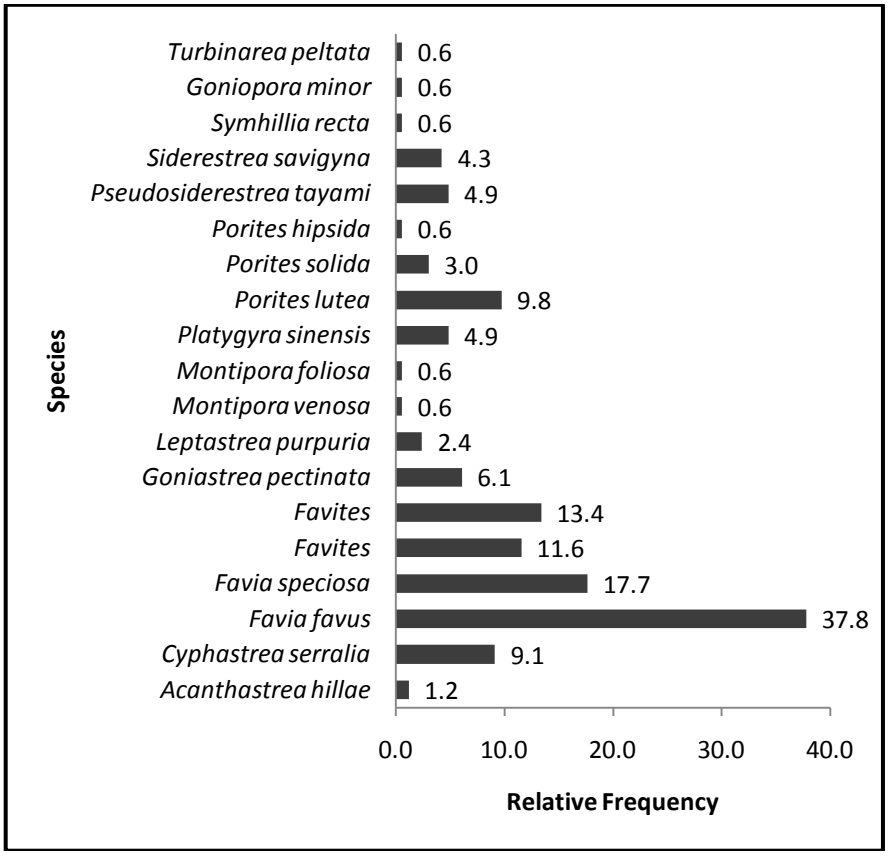

Fig 4: Relative Frequency of Occurrence (%) of coral species at Narara

Preliminary Observations on Nesting of Painted Stork (*Mycteria leucocephala*) in Bhavnagar, Gujarat

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ABSTRACT: Painted Storks regularly breed in Bhavnagar city. I studied them from 2008 to 2012 with emphasis on enumerating number of their nests and determining how does it correlate with magnitude of rainfall each year. I could infer that though magnitude of rainfall and number of nests are inter-linked, some factors other than rainfall might also be responsible for variation of number of nests of Painted Storks in Bhavnagar. A comprehensive ecological study would be required for determining causes of variation in number of nests by Painted Storks in Bhavnagar city from year to year.

KEY WORDS: Bhavnagar, *Mycteria leucocephala*, Nests, Painted Stork, Rainfall, Saurashtra

INTRODUCTION

Several Indian cities, including their outskirts, offer long-term foraging and nesting habitats/sites for colonial waterbirds such as storks, ibises, spoonbills, herons, egrets and cormorants (Urfi, 2010). Some notable examples of such sites include Piele Garden, Bhavnagar City (Parasharya and Naik, 1990), Karanji Tank, Mysore (Jamgaonkar *et.al.*, 1994) and National Zoological Park (Delhi Zoo), New Delhi (Urfi, 1997), Kamla Nehru Zoo, Ahmedabad etc. Due to their permanent nature and easy access, such sites offer a good opportunity to study impacts of environmental or climatic changes on afore mentioned colonial birds; Painted Stork (*Mycteria leucocephala*) being one of them. With the above-mentioned concept, I had studied nesting of Painted Stork (*Mycteria leucocephala*) in and around Bhavnagar City, Gujarat and the present paper is based on some preliminary observations made during my study.

Painted Stork (*Mycteria leucocephala*) is a large and brightly colored wading bird distributed in the Indian Subcontinent, South-West China and also in other parts of South East Asia (Havss, 1963). It is found in lakes, marshes and paddy fields (King *et al.*, 1975; Coulter *et al.*, 1989; Innes, 2001). This stork is slightly less than a meter (i.e., about 56-58 inches) in

height (Innes, 2001). Its food consists mainly of fishes and frogs, which it gets by wading into shallow waters. Nesting season of this stork begins in monsoon in north India, and November to January (may extend till February) in south India. In Bhavnagar city of Saurashtra region (Gujarat, India), the breeding season of Painted Stork commences during August and lasts till February. During nesting period (7-18 weeks), nests are built usually on trees close to the waterbody, with clutch size of 3-5 eggs (Perrins, 1990). Both males and females take part in incubating and rearing the chicks (Gupte, 2001).

STUDY AREA

General description

The study was carried out in Bhavnagar city in Gujarat State of India. Bhavnagar (21°45' N and 72° 08' E) is located in the southeastern portion of the peninsular Saurashtra region of Gujarat. Bhavnagar city is the head quarter of Bhavnagar district and the district has 156 km long sea coast-line with muddy coast that provides suitable feeding ground for many wetland birds. Eastern side of the study area is surrounded by the Gulf of Khambhat (Cambay). The northwestern side of the study area is a huge flat saline wasteland, locally called "*Bhal*". General topography of the study area is flat; therefore rain water does not accumulate in this area. The only freshwater reservoir in the city is *Bor-talav* (also called Gaurishankar lake) and it gets almost dried by the end of May each year. Two streams namely Maleshri and Kansara flow through the study area and merge with the Gulf of Khambhat. The streams get flooded during heavy rains, but water rapidly flows down the slope and dries within a few days.

Moti talav and Tilaknagar areas on the outskirts of the city constituted important observation grounds in Bhavnagar city. They were located at the distance of 2 km from the old port of Bhavnagar. The city has underground sewer system which discharges the sewage in these areas. Grasses sprout out in these areas during monsoon (June-July) and persist upto October, but the major portions of the areas turn into saline waste lands once the rainy season is ceased.

Another important part of my study area was Ghogha port. Its south and north portions constituted muddy seashore and approximately 500 ha of the area was under mangrove plantation by the Forest Department. The mangroves and mudflat provided ideal habitat for mudskippers, prawns, shrimps and other crustaceans which are fished during low tides.

General Climate

Saurashtra is a region of arid to semi-arid climate. However, the climate of Bhavnagar is modest as Gulf of Khambhat surrounds the eastern boundary of the city. There are three distinct seasons in a year viz. monsoon, winter and summer. Rainfall is confined to the monsoon season only and it usually starts from the first or last week of June and prevails up to September and October. Saurashtra is a drought prone area but Bhavnagar, normally receives annual rainfall varying between 600 mm to 800 mm. Rainfall is erratic from view-points of its frequency, duration and intensity. Thus, the distribution of the rain is not uniform in the area. During the rainy season the mean monthly temperature averages between 27° C to 33 ° C.

Growth of vegetation in Saurashtra is severely limited by aridity. Moreover, due to increasingly heavy demand for wood to satisfy the needs of increasing human population has contributed to the scarcity of large trees in major parts of Saurathtra. However, the trees that were planted as the roadside plantations during the princely rule still survive. Besides that, many people have voluntarily cultivated large trees in their premises.

MATERIALS AND METHODS

The study was undertaken for five years from 2008 to 2012. During the study phase, the number of nests of Painted Storks were counted during the month of September every year by covering all the likely trees in Bhavnagar (city and its outskirts).The nesting tree species were identified using help of experts. To substantiate the observations on nesting of the studied avian species, the rainfall data were collected and correlated with number of nests.

RESULT AND DISCUSSION

I have tried to understand the relevance of rainfall with number of nests of Painted Storks in Bhavnagar. My preliminary observations have indicated that the magnitude of rainfall and number of nests of Painted Storks were positively correlated (Fig.1). Thus, Fig.1 indicates that the rainfall went on increasing from 559 mm in the year 2008 to 1002 mm in 2010. The number of Painted Storks' nests too increased from 432 in 2008 to 519 in 2010. The only exception was the rainfall-nesting scenario between 2010 and 2011, as despite the reduction in rainfall from 1002 mm in 2010 to 719 mm in 2011, the number of nests increased from 519 in 2010 to 1029 in 2011. The likely reason is that under the influence of peak rainfall in 2010, good wetland conditions (with associated food and foraging habitat availability) might have retained in the area till the commencement of breeding season in 2011. However, this is only a hypothesis and it is likely that the rainfall may not be the only/strongest factor influencing the intensity of nesting. The possibility that the rainfall may not be the only factor responsible for variation in magnitude of nesting from year to year is that though rainfall was not absent/negligible in 2012, Painted Stork nesting did not occur completely in Bhavnagar during that year. The rainfall was 349 mm in 2012, but there were no drought conditions in the area and thus total absence of nesting by Painted Storks during the year was a phenomenon difficult to correlate only to the low rainfall. 'Zero nesting' by Painted Storks could be justified If there were drought like conditions in the area in 2012. This is because reduced reproductive performance during drought period has been reported in many species (e.g. Ibis) (Carrick, 1962; Ryder, 1967; Dusi and Dusi, 1968). But, as it was mentioned earlier, such drought conditions did not occur in the area and still Painted Stork nesting was completely absent in 2012. It is also very less likely that Painted Storks might had nested elsewhere as these storks in Bhavnagar have been observed to have very strong site fidelity as they are nesting in this colony since last several decades. It is very much likely that though the intensity / magnitude of rainfall may

have noticeable influence on intensity of the Painted Stork nesting, the rainfall might not be the only or the strongest cause for variation in nesting from year to year. Only the detailed ecological study would certainly provide many interesting insights into such exceptional rainfall-nesting pattern in and around Bhavnagar city, Gujarat.

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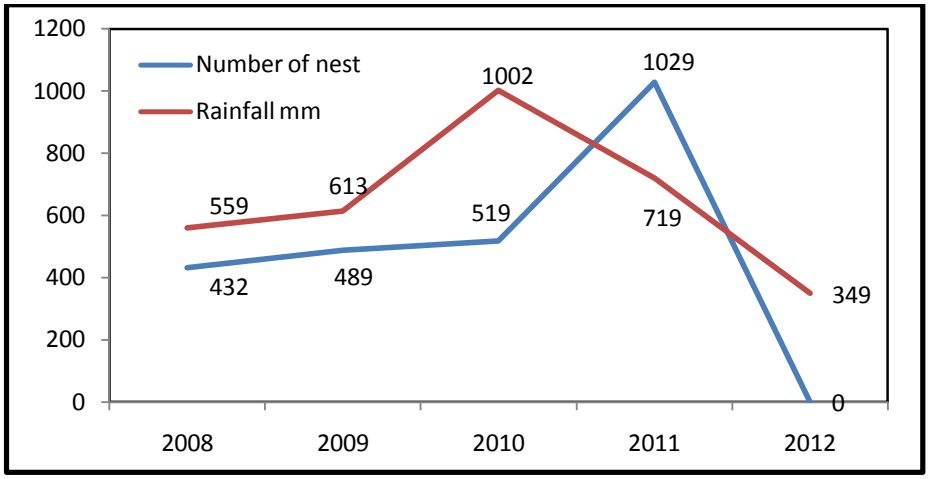

Fig.1. Number of nests of Painted Stork and Rainfall (2008 to 2012) in Bhavnagar

Fig. 2. Painted Stork in a marshland near Bhavnagar

Fig. 3 Painted Stork colony at Bhavnagar

Opportunistic Breeding Behaviour of Indian Sarus Crane *Grus antigone antigone* (Linn.) at a Man-made Wetland in Anand Dstrict (Gujarat)

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ABSTRACT- The Indian Sarus Crane (*Grus antigone antigone*), the world's tallest flying bird and a globally 'Vulnerable' species as per IUCN Red List of Threatened Species is the only resident breeding crane in India. Normally, it breeds in July and August though few lay in some other seasons as late as November. However, a pair was seen indulging in courtship display and nesting behavior in Anand district of Gujarat in the month of February. The paper discusses the probable inferences of such an opportunistic behavior in Indian Sarus Crane.

INTRODUCTION

The Indian Sarus Crane *Grus antigone antigone* (Linnaeus, 1758) is the world's tallest flying bird (Archibald *et al*., 2003) and is the only resident breeding crane in India (Mukherjee *et al.,* 2002) amongst the existing 15 crane species in the world. The Indian Sarus Crane has been listed as 'Vulnerable' avian species by IUCN (2010). The criteria reflect the threat to the species through various means like decline in habitat quality, exploitation, pollution, competitors and parasites. It is obvious that anthropogenic activities, land use changes and degradation of wetlands due to agricultural expansion and industrial development have been found to be the most serious threats to the cranes (Gole, 1989; Parasharya *et al*., 1989). As a result, the species has suffered a rapid population decline within a few decades (Choudhary *et al*., 1999). The Sarus breeds freely over the whole of the North-West Provinces, Oudh (Avadh), and Upper Bengal, and more rarely in the Punjab, Cis-Sutlej, the eastern portion of Rajpootana, and parts of the Central Provinces.

Sarus Cranes breed in July and August, and few lay in some other seasons as late as November (Hume

and Oates, 1889). Nest site selection involves the specific choice of a site to build a nest and it usually occurs just prior to egg laying (Cody, 1985). The nest of a Sarus is a huge heap, a broad truncated cone, composed of reeds and rushes and straw, varying much in size according to situation and circumstances. At top it is about two feet in diameter, with a central depression from four to eight inches deep for the eggs. The species breeds in the area generally during monsoon *i.e.* July to October (Kathju, 2007; Ali & Ripley, 1983; Parasharya *et al*., 1989; Mukherjee, 2000)

STUDY AREA

Anand District having 67,570 ha area classified under wetland of which 4013 ha area of inland wetland during post monsoon season (SAC, 2010). The major agriculture activity of the area is paddy and tobacco (Mukherjee *et al.,* 2000). Only one site *i.e.* Lambhvel sewage pond (Fig. 1) was surveyed for inventorisation of the avifaunal diversity of the area. Lambhvel sewage pond ($22^0$35'1.0" N, $72^0$56'55.38" E), is located north-west, very near to the district head quarter Anand city. The railway track (Anand - Ahmedabad) passing through the wetland is one of the busiest rail route of the state and bifurcates the sewage pond in to two unequal halves with larger eastern part and smaller western part. The influx of the sewage is from west to eastern flow. Due to regular flow of the sewage water the wetland is perennial and heavily dominated by *Ipomoea* sp. The wetland is frequently used as feeding ground by several water birds. The site was visited on 20th February 2010.

MATERIAL AND METHODS

Total count was taken for the population status of the existing waterbird species at Lambhvel sewage pond. The bird identification was done using standard field guides (Grimmet *et al*., 2009). The observations were made with a pair of 10 x 50 Nikon binoculars. The observations were recorded from 830 hrs to 1100 hrs.

RESULTS AND DISCUSSION

Total 41 species of waterbirds were recorded. At 10:00 hrs, a Sarus Crane pair settling 100 meters from the observation point was recorded (Fig. 2 & 3). The two birds took almost 8 to 10 minutes after landing to reach a particular place and settle down. Having a close look through the pair of binoculars, it was found that the birds settled near a platform (that looked like a nest) prepared from vegetation. After settling down near it, both the birds started plucking out the hydrophytic vegetation (*Ipomoea sp.*) from the nearby area, stacking and rearranging the same on the platform. This activity was carried out for about 25 to 30 minutes. After the rearrangement of what appeared like an old nest, one crane sat on the nest (as if to incubate eggs) and the other bird started foraging. Both the birds were observed till 11:00 hrs. One bird also indulged in courtship display for nearly two to three minutes. As the nest was not approachable on foot, the presence/ absence of eggs in the nest could not be confirmed.

Though I fully understand that this was a limited period observation, and a comprehensive study is required, it has two major perspectives (i) Probable delayed breeding and (ii) Availability of habitat. They may be treated as my hypothesis for any further comprehensive study on this subject.

Probable delayed breeding: The Central Gujarat area including the contiguous districts of Anand, Kheda and Ahmedabad is one of the major population concentration areas in Gujarat for the Sarus Crane. As per the census carried out by GEER Foundation in 2010, more than 60% of Gujarat's Sarus population was recorded in these three districts (GEER, 2013). Inundated paddy-fields and associated non-cultivated marshy lands form important nesting habitat for the Sarus Crane in this area (Mukherjee *et al.*, 2000). The paddy sowing also coincides with the nesting period of

the cranes. Paddy is a crop requiring good rainfall. However, the year 2009 was poor precipitation year (Table 1). The total rainfall recorded in the Anand tehsil/taluka of Anand district was 371.20 mm compared to the average of 1060.07 from 2003 to 2009. This might have led to lesser cultivation of paddy in August 2009, ultimately leading to lack/scarcity of suitable nesting habitats and lack of food for the fledglings. In turn, such a scenario might have resulted in the nesting failure in the peak seasons at least for some Sarus pairs. Moreover, some of those, probably like one that I observed, might have indulged in an opportunistic breeding/nesting behaviour.

Availability of habitat: The breeding of Sarus in India has been mainly reported from June to March (Walkinshaw, 1973). However, the peak season of breeding is monsoon *i.e.,* June to August (Parasharya *et al.,* 1989; Mukherjee, 2000). The breeding season of the Sarus Crane in the north-west India, particularly in Kheda (and Anand) district, coincides with the south-west monsoon (Ali & Ripley, 1983, Parasharya *et al.,* 1989, Mukherjee, 2000) providing wide availability of cultivated paddy cropland.

Walkinshaw (1973) has five odd records or observations of nesting of this species in the post monsoon to winter season. However, the available literature on such nesting observations is very rare. Sewage ponds are perennial wetlands with vegetation required for nesting. Despite high nutrient and pollutant load, the bird can opportunistically breed multiple times in a year in such wetland due to the favourable conditions for breeding. Thus, this observation might be of an opportunistic late or multiple time nesting or nesting attempt of a Sarus pair. Such observations are interesting as the area (Anand and Kheda districts) harbours high Sarus population. The observation, though of limited duration, may be considered important as it indicates the need of the published information on the breeding status

of the crane in Gujarat outside conventional breeding season. It is extremely required to study the breeding ecology of the Indian Sarus Crane with reference to availability of the habitat, favourable conditions and rainfall.

ACKNOWLEDGEMENTS

We are thankful to Dr. B M. Parasharya and Dr. C. K. Borad for their valuable technical guidance and encouragement in this research.

Comments of Mr. Kandarp Kathju on the Delayed Sarus Nesting in Anand Reported by Dishant Parasharya

The observations pertaining to the Sarus Crane pair landing at the marshland site in agricultural area of Anand district and then proceeding to pluck vegetation to then place it on a 'platform' is quite typical of the species' nest initiation activity. It is unfortunate that the observation could not be carried out for longer time-frame. I too have seen several Sarus nesting 'outside' the conventional nesting season coinciding with the monsoon months. This, albeit infrequent, occurrence is largely determined by the availability of water and wetland vegetation.

Last year, I had sent the following paragraph on this very topic to someone else: "What one has observed is that pairs (which failed to raise chicks or failed to nest at all due to patchy rainfall in the regular/usual nesting season) tend to start nesting in January-February. This has been seen in the Sanand tehsil/taluka (Ahmedabad district, Gujarat) and inspection of such sites reveal just why. With the Narmada river waters providing a bounty, at least in some areas, for farmers, a feeder canal of the Sardar Sarovar Project (SSP) irrigates parts of Sanand taluka throughout the year in the present times. Seepages from branch feeders fill up small shallow ponds generating the same wetland vegetation used by the Sarus for nest-building. To top it all, local farmers have started growing a *second* crop of paddy (instead of the traditional wheat as the *rabi/winter* crop). This twin feature of marshes with nesting vegetation and paddies, seem to provide suitable nesting conditions outside usual nesting season too. One can therefore infer that the Sarus would nest throughout the year given the right waterlogged conditions and vegetation required by artificial flooding from irrigation canals converting hitherto seasonal marshes; and the switch of crop from wheat to the flooded paddies creating potential nesting sites outside of the monsoon months. (The consequences on the soil quality of going for a second rice crop which means keeping the land inundated for twice the number of months is a different story!)

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Table 1: Rainfall data for the Anand tehsil of Anand district (Source: State Hydrology Data*)

District	Tehsil	Station	2007	2008	2009	2010	Average RF for 2003 to 2009
Anand	Anand	Anand	1139.70	949.50	371.20	527.00	1060.07

(*http://swhydrology.gujarat.gov.in/Documents/Meteorological%20Data/AnnualRainfall2007-2010.pdf)

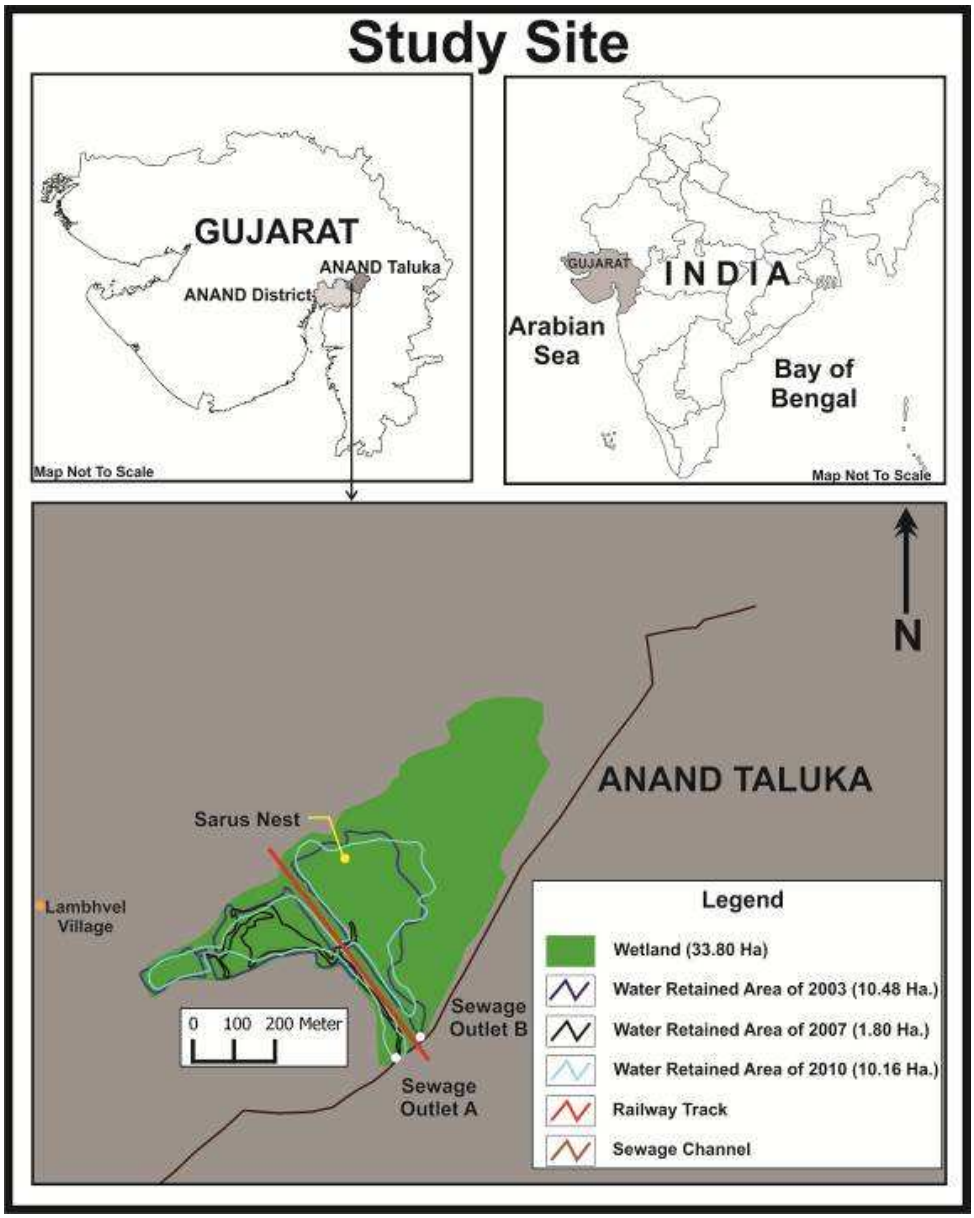

Fig 1: The study area

Fig 2: Nest reconstruction by the Sarus Crane pair

Fig 3: A Sarus Crane on the 'nest'

Use of Bioturbation Structures in Coastal Wetlands as an Important Tool in Benthic Faunal Studies

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ABSTRACT: Macro-benthos act as a dominant and active group in the coastal wetland food chains and therefore they are important from the view-point of wetland ecological studies. Till date, traditional methods are widely used field methods in studying benthos. However, these methods often face limitation in implementing. Such being the case, biogenic/ bioturbation structures(e.g., burrows, pellets), which vary from species to species offer clearly visible structures on tidal mudflats and can be used as important tools in coastal benthic faunal studies. A study which was carried out at tidal flat of Mahi river estuary and coastal parts of Gulf of Khambhat has helped in identifying some bioturbation structures that can indicate presence and activities of macro-benthos in the tidal mudflats.

KEY WORDS: Benthic species, Biogenic Structures, Bioturbation Structures, Macro-benthos

Tidal flats form one of the integral parts of coastal wetlands owing to its highly dynamic nature and being a nurturing ground for varied benthic species (Gray, 2002). Macro benthos act as a dominant and active group in the coastal wetland food chains (Levin *et al*., 2001). Till date, traditional methods like sieving, live animal sampling and visual observations of animal on transect belt in most cases are widely used field methods in studying benthos. Sighting of these species in such studies largely depends on environmental variables like tide timings, moon days, season, pre and post high tide intervals, time of field visit etc. Additionally, many of these species being opportunistic, swift or camouflaging to the surrounding, often remain unnoticed to the researcher.

The intimate active and passive interactions of benthos with the sediments give rise to sedimentary structures or called biogenic structures which vary from species to species. These clearly visible structures especially on tidal mudflats can be in the form of diverse burrows, pellets (feeding, excretory or burrowing), track and trails of animal on soft mud, feeding marks etc. The detailed classification of biogenic structure and

its respective behavioural mark was given by Seilacher, 1953 and revised later by Pemberton *et al*., 1992. These structures usually forms the trace fossils or ichnological evidences which are extensively investigated to study the geological past of the area (Hembree and Hasiotis, 2007; Martin, 2009). The study of modern tidal flats in India especially in ecological concern however, is still fairly limited (Chakrabarti, 1980, 1981; Mukherjee *et al.,* 1987; Bhattacharya, 2000). Looking to the available literature, it can be seen that most of the biogenic/ bioturbation structure studies are using the past/fossilized track or signs of animals known as ichnofossils.

Indirect evidences like pugmarks (foot-prints), animal excreta/remains, track and trail marks etc. are being used in wildlife studies since long. I have hypothesized and applied the same strategy/approach for my multiple benthic faunal studies, in which I have used indirect evidences in the form of the fresh marks/signs of the benthic animals on the tidal flats to understand their presence and activities. I propose that once standardized and documented, these structures can work as indicators of the presence of rare animal in absentia, can suggest the animal distribution, can suggest the relationship of animal with the habitat and facilitate behavioural studies. In this small paper I have attempted [with small example of my study in Gulf of Khambhat (Gujarat)] to derive and suggest the use of afore-mentioned indirect evidences in coastal ecological and benthic studies.

The present paper is based on the larger study which that was carried out at tidal flat of Mahi river estuary and coastal parts of Gulf of Khambhat. As mentioned, the area represents a prominent mudflat with varying amount of sand-silt-clay composition at different intertidal levels. The work initiated with regular observations of animals in order to reveal their specific signs. Focal animal ethological studies were done by tagging the burrow of the animal with a coloured flag which can be video recorded and noticed from

long distance without disturbing the animal. These structures documented and studied were cross verified for other areas with similar habitat conditions and assured that in 98 % cases the animal marks and signatures remains same ensuring presence of that particular species.

The biogenic/ bioturbation/ sedimentary structures

Various animal activities, actively or passively mark the presence of the species in its absentia which can reveal its identity, distribution range, interaction with the given habitat, its size to certain extent etc. which otherwise in such many cases are difficult to access and demand extensive field observations. Yet, these required pre-authentication and thorough observations to record species specific structures and their signs. Once documented, the regular cross-checks and verifications minimize the chances of human error or mis-interpretation during the ongoing study. Some of the studied species with their indirect signs/ structures are presented in Table 1.

Apart from this, mudflats have potential to imprint the activities interspecific or intraspecific acting at very finer level which are usually difficult to study and document as such. Ornithological imprints like foot marks of waders, feeding attempt of mud probing birds can be documented which help otherwise to study the prey-predator relationship of birds and benthos in wetland ecosystem at very fine level *(*Fig. 4*)*.

The present tool can be more precisely formulated and applied for larger areas which can decrease the time for observation and ensure the presence of a particular species in the new range in absence of the species. Moreover, this kind of documentation can aid in the identification and interpretation of similar ichnofossils in the geologic record and help improve paleoenvironmental and paleoecological database and studies especially for many coastal wetlands.

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Table 1. Some of the benthic animals studied, their habitat and marks and signs of bioturbation.

Species	Habitat type	Type of sign	Description of mark
Macrocera sp. (Ghost crab)	Sandy coast	Burrowing pellets	Round burrowing pellets in sandy, silty area or a prominent sand mound close to the burrow or at some distance. The burrow diameter ranges from few 3 – 7 cms depending on the size of the crab.
Cardisoma carnifex (Moon crab)	Muddy coast	Burrow mouth and walking leg marks.	Burrow mouth typically inclined, oblong and water logged specially in intervals recently after high tides. Conspicuous marks of walking legs are visible in close vicinity of the burrow. *(fig.1 a)*
Mudskipper sp.	Muddy coast	Burrow opening, burrowing pellets and walking trail.	A very peculiar burrow opening with circular depression on the periphery which is usually seen water logged. Trail marks of the dorsal fins can prominently disclose the identity of the mudskipper as well as the approximate size. *(fig.1 b)*
Uca lactea annulipes	Muddy coast	Burrowing pellets	Burrow aperture perfect round. Large mud balls of 1-1.5 cm diameter can be seen piled at some distance or spread around the burrow. *(fig. 3 a)*
Dotilla sp. (Sand bubbler crab)	Muddy/ partially silty-sandy coast)	Burrow ornamentation, feeding traces	Burrow aperture small ~ 1-2cm with chimney formation in some cases. Feeding in the adjacent area causes art-effects of feeding pellets. Feeding marks of chela visible. *(fig. 2 a & b)*
Assimenia sp. (Boring gastropods)	Muddy coast and mangrove habitats	Burrowing marks	Small burrow aperture with spiral burrowing pellets reflects the burrowing activity the species. *(fig. 3 b)*
Nemertine sp.(Nemertine worm)	Muddy / muddy-sandy mixed coast	Movement trails	Centered with small burrow aperture, the trail marks in the form of vertical bands can be seen in asteroid form or in a particular direction.

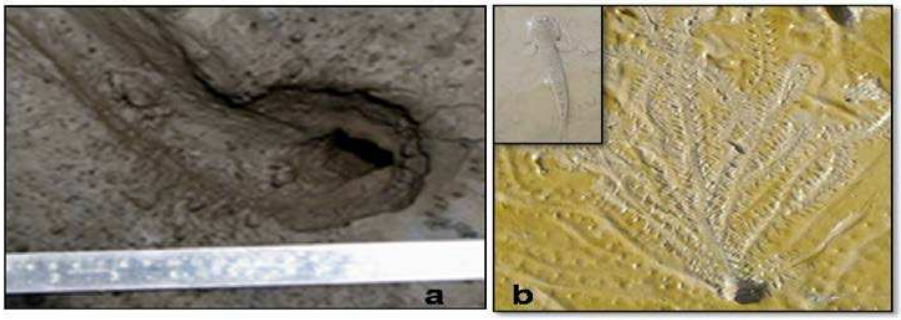

Fig. 1. a. Burrow structure and adjacent walking legs marks of *Cardisoma carnifex*. b. burrow and walking trail marks of mudskipper.

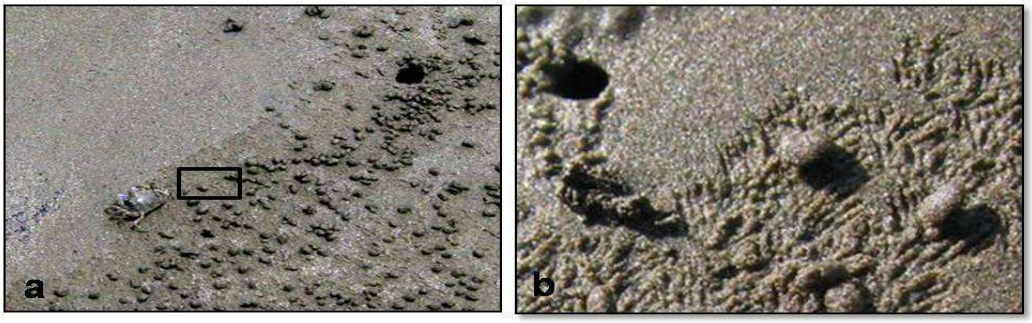

Fig. 2. a. Burrow aperture, feeding pellets and marking of *Dotilla sp*. . inset (b) magnified marked area shows the feeding marks/scraping done by the chela of the crab.

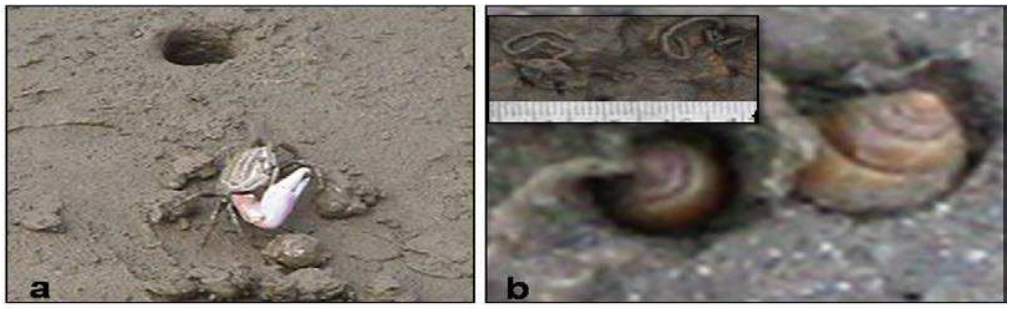

Fig. 3. a. Burrow and typical fresh burrowing pellet of the fiddler crab *Uca lactea*. Crab piling the burrowing pellets on one side of the burrow. b. The tiny gastropods *Assimenia sp*. burrowing with their screwing movement, inset shows the tubular coiled pellet formed due to this activity.

Fig. 4. Probing attempts of the wader marked on the mudflat along with foot-print.

Survey of Vertebrate Fauna along the Select Segments of Some Rivers of Central Gujarat, India

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ABSTRACT- I surveyed 10 km long segments/stretches, each along the rivers Sabarmati, Vatrak, Mahi, Vishwamitri and Mini Nadi flowing in Central Gujarat for vertebrates, including aquatic reptilian fauna and overall environmental status. The highest number of species of vertebrates (*i.e.*, 102) were sighted along the Mahi and lowest number of species of vertebrates (*i.e.*, 77) were recorded along the rivers Vishwamitri and Sabarmati. High diversity of birds (*i.e.*, 73 species) and mammals (*i.e.*, 12 species) was recorded for the Mahi and good number of reptiles (*i.e.*, 10 species) and amphibians (*i.e.*, 10 species of frogs) were recorded for the river Vishwamitri and the river Vatrak respectively. The most degraded river stretches were that of Sabarmati, Mini, and Vishwamitri rivers. I found Vatrak River to be comparatively healthier and the healthiest river belt is Mahi River.

KEY WORDS: Diversity, Environmental status, Gujarat, Mahi, Mini Nadi, river, Sabarmati, Vatrak, Vertebrates, Vishwamitri

INTRODUCTION

The 'River' or 'Riverine Area' has remained the most crucial element in the development of the societies and civilizations. These rivers have been a witness to the rise and fall of numerous civilizations that they once harbored. Today, as a matter of fact, the remnants of the past are still excavated from the banks of the rivers.

According to the 'Hindu' philosophy, rivers are considered divine (Haberman, 2006). Many 'Hindus' believe that rivers are goddesses and therefore they worship rivers. But like every other aspect of our life, modernization has made some alterations to the Hindu philosophy. With the blur idea of reverence to the rivers at the back of their minds, most of the Indians now consider the rivers as garbage dumping grounds. The rivers have been taken for granted as the national property vulnerable to any sort of pollution and waste disposal. So, now the rivers are no more goddesses, but large open aboveground sewers flowing through big cities. I have attempted to assess the health of few rivers in Gujarat, especially the river stretches, carving through the big cities or industrial zones on the basis of visual evidences, people's interviews and vertebrate faunal surveys.

STUDY AREA

The rivers Sabarmati, Mahi (major), Vishwamitri, Vatrak and Mini Nadi (minor) in Central Gujarat were considered for the study. A 10 km-river stretch/segment had been selected along each of these rivers. On one hand, these river stretches/segments were located down-stream of the cities or industrial zones and on the other hand they were also located in remote areas surrounded by agricultural fields. The 10 km-river segments/stretches along the five select rivers were situated in four districts of the State. Thus, the river segment/ stretches of Mini and Vishwamitri rivers were located in Vadodara District, whereas that of the Vatrak and Sabarmati rivers were located in Kheda and Ahmedabad districts respectively. The river stretches of Mahi shared a common border of the two districts of Vadodara and Anand (**Fig. 1; Table 1**). The topography of the area and some salient features, with other relevant details of all the five rivers are provided in the **Box 1**.

METHODOLOGY

On each of the five select rivers, a 10 km long river segment/stretch with the width of half km from each opposite bank was considered as a 'Survey Block'. Each selected Survey Block on every selected river was intensively and repetitively surveyed and all important and necessary data were recorded by 1) visual encounter survey (as per animal groups), 2) transect survey (only at a few locations within each block), 3) recording the species through indirect evidences like foot prints, shell, skin, molt, burrows, droppings and sounds. Additionally, secondary information was gathered about different species of wild/limno-fauna by interviewing local people of surrounding villages, fisher men, forest personnel and wildlife enthusiasts. The overall condition of the rivers was also assessed by interviewing local people. This study was carried out during the monsoon and pre-summer period between August and September 2008 and again in February 2009. Total 60 days were spent for the field work. The

taxonomy and species nomenclatures mentioned in this document were adopted from those of Ali & Ripley (1983), Grimmett *et. al.* (2003; 2011), Rasmussen & Anderton (2012) and Kazermiczak (2000) for birds, Nameer (2008) and Wilson & Reeder (2005) for mammals and Das (1994 & 2003), Aengals *et al.* (2011) and Reptile Data Base (2013) for reptiles and Frost (2013) for amphibians.

Box-1

SALIENT FEATURES OF RIVERS SELECTED FOR THE STUDY

River Vishwamitri: The River Vishwamitri (=Vishvamitri) is one of the seasonal rivers having the length of over 250 km of Gujarat State and it flows from east to west in between two large perennial rivers Mahi and Narmada. Vishwamitri River originates from Pavagadh hills, Panchmahal District, flows westwards through Vadodara city and further merges with two other small tributaries (meets the Jambuva tributary at Khalipur village, and Dhadhar branch near Kothawada village) and finally reaches the Gulf of Khambhat(Cambay) near Khanpur village, Bharuch District. Two water reservoirs are constructed on the river system, Sayaji Sarovar near Ajwa village on Vishwamitri river and Dev Dam on its Dhadhar branch, for consumption and irrigation purposes. The Vishwamitri River flows through Vadodara City and so sewage of the entire city and nearby industries (Kalali and Makarpura) is drained into the river which adds immense amount of pollutants in the river. This polluted river holds little wildlife including a small population of mugger crocodiles (*Crocodylus palusris*).

River Mini Nadi: The Mini Nadi is a small seasonal 55 km long rivulet tributary of the Mahi River. This small river originates somewhere in south-east Planes of Savali area and further flows left side parallel to Mahi, east to west-south and finally merges with Mahi in the west of Sindhrot village, Vadodara District. This small river flows through a few industrial areas of Vadodara district. These industries (Nadesari GIDC, Panoli Industrial Estate and Indian Refinery) release huge amount of toxic effluents in the river, making it a highly polluted river in Vadodara District.

River Mahi: River Mahi (=Mahi Sagar) is a l 576 km long perennial river. It flows through three states of Rajasthan, Madhya Pradesh and Gujarat. It originates from Gomanpura, Malwa Plateau of the Vindhya hills, north-west Madhya Pradesh and flows west-south towards Gujarat and finally reaches the Gulf of Khambhat at Kavi-Degam, Bharuch district. The Goma, Mesari, Panam, Karad, Haran and Machundri are the main tributaries of the river and all meet it on its left bank. There are a number of small/ big dams (e.g., Mahi Bajaj Sagar in Rajasthan, Kadana and Wanakbori in Gujarat) constructed on the various tributaries of the river, which irrigate large areas of the state. This large river harbors important wildlife.

River Vatrak: River Vatrak is a river about 300 km long. It is a non-perennial tributary of Sabarmati River. It originates from Dungarpur District, Rajasthan. By nature it is non perennial, but waters of the downstream river continuously flow. This is due to the excess water from Mahi and Narmada Irrigation Canal systems being released in the river. Originating in southern Rajasthan, it flows from south-east to South-west through Sabarkantha and Kheda districts and finally merges with river Sabarmati at Palla- Vautha villages (Vautha village is on right bank). The Meshwa, Majam, Shedhi and Mohar are the main tributaries of the river Vatrak.

River Sabarmati: The River Sabarmati is a perennial, 371 km long river. It originates from the Aravalli hill range in the west of Udaipur District on the border of south Rajasthan as Wakal River and flows southwards to Gujarat, finally ending in the Gulf of Khambhat(Cambay) at Golana-Vadgam, Anand district. There are over a dozen tributaries, which are Wankal, Harnav, Hathmati, Khari, Meshwa, Majam, Vatrak, Shedhi and Mohar. They flow from Sabarkantha and Kheda districts and finally all meet Sabarmati on its left bank. The Bhogava, is the only tributary that joins Sabarmati river at its right bank. This is one of the beautiful scenic rivers with potable clean water. But its beauty remains up to Gandhinagar city only. Once the river enters Ahmedabad city, it transforms into a large polluted sewage river. At Golana-Vadgam, near Gulf of Khambhat, it turns into almost a blackish red colored river.

RESULTS & DISCUSSION

The survey results regarding the wild/ limno-fauna (amphibians, reptiles, birds and mammals) (**Appendix 1, 2 3. & 4**), and the local usage of the river banks and river water by local people with respect to the 10-km study blocks for each river are briefly described below:

River Vishwamitri: The Vishwamitri Survey Block was surrounded by six villages of Vadodara District. People of all the six villages used the river water for various purposes like agriculture, cattle-cleaning, washing clothes/ utensils and bathing (Table 2). However, visual assessment and interaction with local people revealed that the water quality was not good from the view-point of drinking water quality.

Aquatic Animals: Two species of aquatic reptiles were noted; including one species of turtle and a species of crocodile (i.e., mugger crocodile) in the Survey Block. Total six mugger crocodiles (*Crocodylus palustris*) were sighted in the Survey Block that included three crocodiles sighted near Khalipur at the confluence of the Vishwamitri and Jambuwa rivers. Two adults were found between Jambuva and Juni Karali villages (Fig. 2) and a sub-adult mugger was found in a small puddle at the entrance of Juni Kareli (Fig. 2a). Only, one species of fresh water turtle (Indian flap-shell Turtle: *Lissemys punctata*) was present in the study area in a small number near the Vishwamitri-Jambuwa confluence area. The Vishwamitri river is home to number of Mugger Crocodiles and recent data show the population of the species increased well in entire river system (Vyas, 2010; 2012)

River Mini Nadi: The Mini Nadi' Survey Block was surrounded by seven villages of Vadodara district. The entire Survey Block was topographically high with terrain and ravines having thorny scrub forest and few agricultural lands. Very few agricultural fields were found on both the banks in the Survey Block. The villagers of Jasapara and Sherkhi used the water for irrigation purposes (Table

2). The river bank sands and earthen soils were used by local people at very small scale for construction and road leveling work. Aquatic Animals: None of the aquatic vertebrates (neither turtles nor crocodiles) were sighted, but a small number of fishes were found floating dead and some in an awkward upside down position suffering from severe breathing problems in the downstream portion of the river (near Sherkhi village). The dead/choking fishes indicated bad water quality due to pollution. The river water was brown coloured (Fig. 3).

River Mahi: The Mahi Survey Block was surrounded by eleven villages of Vadodara and Kheda districts. People of all the eleven villages used the river water for various purposes, including drinking, agricultural, fishing, cattle cleaning and for other domestic purposes, like washing clothes-utensils and bathing (Table 2). Thus, the quality of river water was good and potable. In fact, there were six to seven 'Water Pumping Stations' on the upper streams on the left bank of the river and these stations were owned by the Vadodara Maha Nagar Seva Sadan (Vadodara City), Refinery Township (IOC), Gujarat State Fertilizer Company (GSFC) and Indian Petro Chemicals Limited (IPCL=now Reliance Petro Chemicals). But, all pumping stations were not within the demarcated Survey Block, except an IOC potable water pumping station located in the upper stream area of Survey Block. Small scale fishing activities were observed in the entire Block, where the local fishermen and non-Gujarati 'Bihari' fishermen were found fishing in the river with traditional methods. Moreover, small scale sand mining industries were in operation on the right bank at Kanhawadi village and on the entire left bank of the river. Aquatic Animals: Two species of aquatic reptiles, including two species of turtles; Indian soft-shell turtle (*Nilssonia gangeticus*: Fig. 4) and Indian flap-shell turtle (*Lissemys punctata*) were sighted in a good number in the entire study area. The distribution and

population of Indian soft-shell turtle was fairly intermediate. The distribution of Indian flap-shell turtle was restricted to some areas where the river-flow was slow and growth of aquatic vegetations was considerable. The concentration of Indian soft-shell turtle was high in and around the deep pools of river and near the village crematorium. Any turtle nest or any nesting activities of these animals was not recorded in study area.

River Vatrak: The Vatrak Survey Block was surrounded by eight villages of Kheda district. People of all seven villages used the river water for various purposes like agriculture, fishing, cattle cleaning and other domestic purposes. It was observed and noticed visually that the river water was not consumable. Undesirable water quality was confirmed by the fact that the villagers of the seven villages did not use the river water for drinking purposes. During the study I observed a number of water pumps fitted on both the banks of the river for pumping of water for irrigation of individual agricultural lands. The agricultural practices of various types of crops were found in progress for the crops like paddy, cotton, millet, jawar, castor oil seeds, fodders (*Sundhiu* grass & *Rajko*) and various types of fruits & vegetables (Table 2). The fishing practice was found to be very traditional and limited. Fishermen used two types of nets for fishing – throw net and drag net. According to a fisherman of Vasana-Bujarg, the fish-catch was very low and after long hours of hard work only small fishes could be caught. Most of the villagers of Mahelaj belong to Muslim community and they regularly practice fishing in the river. They used 'throw net' and 'sit & fix net' for fishing.

Aquatic Animals: Total three species of turtles, namely, Indian soft-shell turtle (*Nilssonia gangeticus*), Indian flap-shell turtle (*Lissemys punctate)* and Indian roofed turtle(*Pangshura tecta)* and marsh crocodile existed in the Survey Block. According to Mr. Kasam Mohmad (Mahelaj), they caught a small sized crocodile along with the fishes in the last year

monsoon (2007). The crocodile was about one meter long and a healthy one. He immediately released it in the same area of river belt. Also, Mr. Manubhai Rathod (fisherman of Vasana) reported that a large (2 meter long) crocodile was sighted in 2006 floods in the river and disappeared from the area after two days. It might have come from the village pond of Traj, where a small population of crocodiles is flourishing well (Vijaykumar, 1997).

River Sabarmati: The Sabarmati Survey Block was surrounded by eight villages of Ahmedabad district. All eight villages' used the river water for agricultural and cattle washing purpose. The agricultural practice of various types of crops including paddy, cotton, castor oil seeds, fruits and vegetables (**Table 2**) was operational in the area. There was an irrigation co-operative society, which operated pumping station on left bank near Miroli village. The Miroli Irrigation Co-operative Society had been pumping large amount of water from the river. There were six water pumps working regularly day and night; pumping huge amounts of water from the river and through the canal system, irrigating agricultural fields of Navapura, Miroli, Timba and Paladi villages. The entire river stretch/segment had become highly polluted and surrounding habitat was also degraded. No life-form (vertebrates) was found in the water, except some of the pollution resistant macro and microscopic animals of the lower phyla. They included insects and bacteria. On both the banks few water-birds were sighted during the study. Large scaled sand mine was found operational on the left bank at Miroli for sand collection for the construction purpose too. Two large Bulldozers (JCB) machines had been working to collect sand for construction.

Aquatic Animals: During the study I did not find any vertebrate life in Sabarmati water. It might be related with the condition of river water that was highly polluted (Fig. 5).

Associated Vertebrate Fauna

The amphibians, reptiles, birds and mammalian diversity of each individual Survey Block of the rivers is shown in Fig. 6. Highest number of species of vertebrates (i.e., 102) was sighted along the Mahi Survey Block and lowest number of species of vertebrates (i.e., 77 species) was sighted along Vishwamitri and Sabarmati Survey Blocks respectively. High diversity of birds (i.e., 73 species) and mammals (i.e., 12 species) was recorded along the Mahi river and good number of reptiles (10 species) was note along the Vishwamitri river. Moreover, good amphibian (frog) diversity was recorded in the Vatrak Survey Block.

Important Wildlife

From the view-points of conservation value and protected species under wildlife law, few most important species of wildlife, including five species of reptiles, one species of bird and two species of mammals were recorded in the Survey Blocks.

The striped hyena (*Hyaena hyaena*) in Survey Block of Mahi (near Asarma on right bank) was recorded through indirect evidences (i.e., droppings and footprints). The record of striped hyena mentioned on the Survey Block of Mini Nadi river was by the reports of villagers of Angadh and Sherkhi villages. The leopard (*Panthera pardus*) was not sighted during the present study, but it was included in the list of animals recorded in this study on the basis of past records of species' occurrence in two Survey Blocks of Mini Nadi and Mahi rivers (Fig. 7). There is a probability of some stray individuals somehow having entered into the area and only to disappear again. They might have come through the terrains and ravines of the river in search of prey. One or two solitary animal sightings of common monitor lizard (*Varanus bengalensis*) in four Survey Blocks and its report along the Survey Block of the river Sabarmati are interesting in my opinion, but I also opine that this reptile might have visited the river banks only for foraging. The sighting of few pairs of Sarus Cranes (*Grus antigone*) in the Survey Block of Vatrak river is also noticeable (**Fig. 8**). This is a

wetland bird species and is found in surrounding wetlands and marshy areas like paddy fields commonly. The presence of this globally "Vulnerable" species along the Vatrak river stretch may be due to its roosting life requisite.

The survey results of river water utility and anthropogenic activities by surrounding villages of the river segments/stretches undoubtedly indicate (without any laboratory analysis) that the water of the rivers Vishwamitri, Mini Nadi and Sabarmati is heavily polluted. In comparison, water of the river Vatrak is less polluted and therefore still traditional fishing activities were observed. Water of the Mahi River was found to be un-polluted and consumable too.

CONCLUSION

Present survey of the freshwater turtles, crocodiles, other wildlife & wildlife habitats, anthropogenic activities and utility of 10 km-river stretches of five select rivers of Gujarat has indicated water quality and vertebrate diversity along 10 km stretches of each of these five rivers. I assessed the health of the river-stretches based on population of limno-fauna (turtles and crocodile, other reptiles, birds and mammalian species), along with the usage of water (in the river-stretches under investigation) by the surrounding villages and anthropogenic activities, and with past published data. Most degraded 10 km- river-stretches were that of the rivers Sabarmati, Mini and Vishwamitri. Vatrak river (with 88 species of limno-fauna) and Mahi river (with 94 species of limno-fauna) were found to be comparatively 'healthier' and the 'healthiest' rivers respectively based on the higher limno-fauna they supported as compared to that by other three rivers. During the study period, I found breeding or nesting activities of neither turtles nor crocodiles along any of the 10 km- river stretches. Such a scenario might be due to low density/numbers of the species and less potential riverine habitat structures (for such activities) in comparison to other parts of upper river streams. Also, higher intensity

of anthropogenic activities in the segments/stretches of the rivers might be a probable reason.

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Table 1
The list of rivers and End-point villages of Survey Blocks, Gujarat

No.	Name of River	Geographic co-ordinates of center-points of 10 km-river stretches (Survey Block)	The End-points (villages with districts) of 10 km- river stretches/segments
1	Vishwamitri	22° 11' 57.10" N: 73° 9' 35.75" E	Khalipur (Vadodara) – Maretha/Maneja (Vadodara)
2	Mini Nadi	22° 21' 20.86" N: 73° 4' 47.5 E	Sherkhi (Vadodara) –Angadh (Vadodara)
3	Mahi	22° 22'27.18" N : 73° 3'18.56" E	Kotna (Vadodara) – Amrol (Anand)
4	Vatrak	22° 42' 49.99" N: 72° 37' 21.06" E	Pipariya+Koshiyal – Vasanha Buzarg (Both in Kheda)
5	Sabarmati	22° 51'55.01" N: 72° 29'50.83" E	Miroli (Ahemdabad)- Koshindra (Ahemdabad)

Table 2
List of villages situated in the surroundings of each 10 km-river segment/stretch, and use of river water and river stretch by local villagers.

No.	Name of Village/ Boundary	Use of river water	Use of river banks & types of agricultural crops
I	**Vishwamitri Left Bank Area**		
1	Maneja	CC, W, I	Co, COS, Mi
2	Maretha	CC, W, I	Co, COS, Mi
3	Jambuva	CC, W, I	Co, COS, Mi
4	Juni Karali	CC, W, I	Co, COS, Mi
	Vishwamitri Right Bank Area		
5	Chapad	CC, W, I	C, COS, Mi, CS, BF
6	Khalipur	CC, W, I	C, CO, Mi, CS, BF, Fl,
II	**Mini Nadi Left Bank Area**		
1	Ranoli	---	
2	Koyali	----	
3	Rampura-Jaspura	I, CB	CF, Ma, Ve
4	Sherkhi	I, CB	CF, Ma, Ve
	Mini Nadi Right Bank Area		
5	Nandesari	---	
6	Anagadh	CB	
7	Bhilapura	----	

III	**Mahi Left Bank Area**		
1	Fajalpur	D, B, CC, F, I	Co, Mi, Ma, Ve, CS, BF, SM
2	Nandesari	D, B, CC, F, I	Co, Mi, Ma, Ve, CS, BF, SM
3	Anagadh	D, B, CC, F, I	Co, Mi, Ma, Ve, CS, BF, P, SM
4	Kotana	D, B, CC, F, I	Co, Mi, Ma, Ve, CS, BF, CF, SM
5	Sindharot	D, B, CC, F, I,	Co, Mi, Ma, Ve, CS, BF, P, SM
	Mahi Right Bank Area		
6	Bhanpur-Bhetasi	D, B, CC, F, I,	Co, Mi, Ma, CS, BF, SM
7	Kanhawadi	D, B, CC, F, I,	Co, Mi, Ma, Ve, CS, BF, SM
8	Amarol	D, B, CC, F, I,	Co, Mi, Ma, Ve, CS, BF,
9	Ram Pura	D, B, CC, F, I,	Co, Mi, Ma, Ve, CS, BF,
10	Asarma	D, B, CC, F, I,	Co, Mi, Ma, Ve, CS, BF,
11	Umeta-Bridge	D, B, CC, F, I,	Co, Mi, Ma, Ve, CS, BF,
IV	**Vatrak Left Bank Area**		
1	Matar	B, CC, F, I,	Co, Mi, Ma, Ve, CF, COS
2	Pimpariya	B, CC, F, I,	Co, Mi, Ma, Ve, CF, COS, SM
3	Koshiyal	B, CC, F, I,	Co, Mi, Ma, Ve, CF, COS
4	Mahelaj	B, CC, F, I,	Co, Mi, Ma, Ve, CF, COS
	Vatrak Right Bank Area		
5	Hariyala	B, CC, F, I,	Co, Mi, Ma, Ve, CF, COS
6	Vasana-Bujarg	B, CC, F, I,	Co, Mi, Ma, Ve, CF, COS
7	Chandana	B, CC, F, I,	Co, Mi, Ma, Ve, CF, COS
8	Radhu	B, CC, F, I,	Co, Mi, Ma, Ve, CF, COS
V	**Sabarmati Left Bank Area**		
1	Paldi-Kankaj	CC, I	Co, Mi, P, Ve, CF, COS
2	Miroli	CC, I	Co, Mi, P, Ve, CF, COS, Large scale SM & Cooperative Irrigation Pumping Station
3	Kasindra	CC, I	Co, Mi, P, Ve, CF, COS
4	Mahijada	CC, I	Co, Mi, P, Ve, CF, COS
	Sabarmati Right Bank Area		
5	Vanzar	CC, I	Co, Mi, P, Ve, CF, COS
6	Bakro-badrawada	CC, I	Co, Mi, P, Ve, CF, COS
7	Kasindra	CC, I	Co, Mi, P, Ve, CF, COS
8	Saroda	CC, I	Co, Mi, P, Ve, CF, COS

(D=Drinking B= Bathing; CB=Cattle Cleaning, F= Fishing; I= Irrigation; RB=Boating-Recreational; Co=Cotton, Mi=Millets,Ma=Maize, Ve=Vegetables, CS=Cane Sugar, P=Paddy BF=Banana Farming, CF=Cattle Fodder, SM= Sand mining

Table 3
Summary of wildlife diversity, anthropogenic use and utility of river banks at five SAL of River Vishwamitri, Mini Nadi, Mahi, Vatrak and River Sabarmati.

	Vishwamitri	Mini Nadi	Mahi	Vatrak	Sabarmati
Amphibians	8	4	8	10	2
Birds	54	60	73	68	64
Reptiles	10	5	9	12	8
Mammals	5	11	12	8	3
Total	**77**	**80**	**102**	**98**	**77**
Important Species	*C. palustris, L. punctata*		*N. gangeticus, L. punctata*	*C. palustris®, N. gangeticu®, L. punctate, P. tecta*	
Density					
C. palustris	0.5/km	Not Found	--	Reports only	Not Found
N. gangeticus	Not Found	Not Found	5.0/km	Reports only	Not Found
L. punctata	SND	Not Found	SND	2.0/km	Not Found
P. tecta	Not Found	Not Found	Not Found	5.0/KM	Not Found
Use of River Water	CC/ W/ I	None -	D/ F / B CC / W/ I	F/ B/ CC /W / I	CC / I
No of Use	**3**	**0**	**6**	**5**	**2**
Use of River Bank		Industrials effluent canal	Sand Mining Water Pumping Station	Sand Mining	Sand Mining Sewage Pumping Station
Water Quality	Black-brown	Red-brown	Color-less	Light brown	Dark Black-brown

(®= Reported Species; SND=Status Not Determined; W=Washing; CC=Cattle-Cleaning; I= Irrigation; D=Drinking; F=Fishing; B=Bathing)

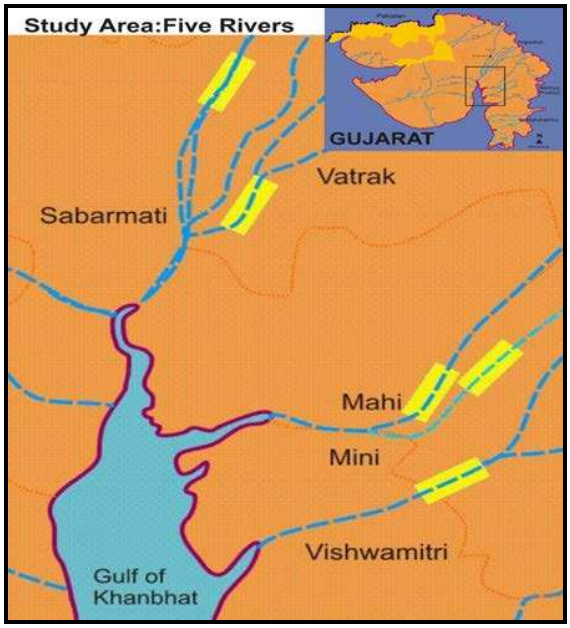

Fig.1. Five rivers selected for the study

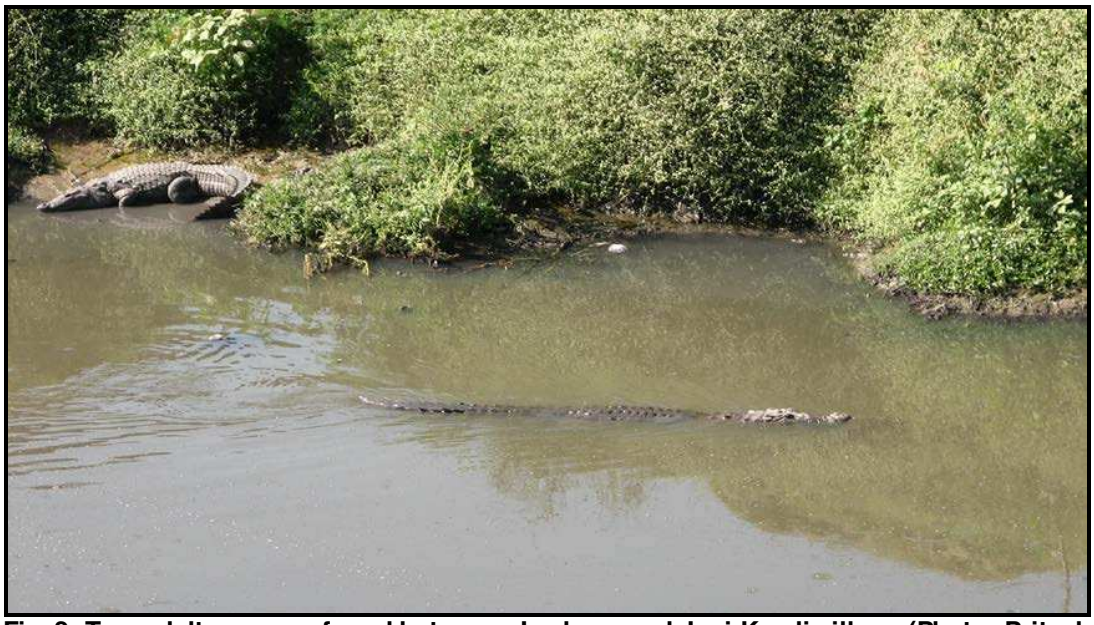

Fig. 2. Two adult muggers found between Jambuva and Juni Karali villages(Photo: Pritesh Patel)

Fig. 2a. A sub-adult mugger was found in a small puddle at the entrance of Juni Kareli (Photo: Raju Vyas)

Fig.3. A view of the river Mini Nadi(Photo: R. Vyas)

Fig. 4. Indian soft-shell turtle in Mahi (Photo: K. Upadhyay)

Fig.5 Highly polluted Sabarmati river water (Photo: Raju Vyas)

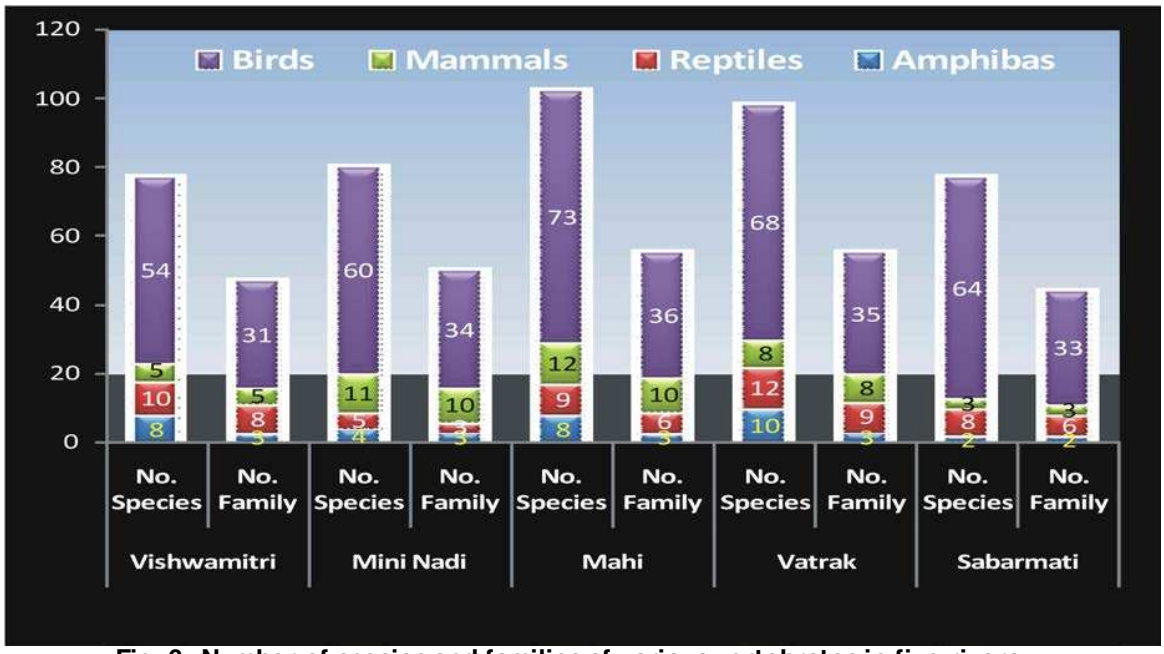

Fig. 6. Number of species and families of various vertebrates in five rivers

Fig.7. Foot-prints of a leopard on the Mahi riverbed (Photo: R. Vyas)

Fig.8. Sarus Cranes on a river segment/stretch (Photo: Raju Vyas)

Appendix-1: List of Amphibian species recorded in 'Survey Blocks' of the five rivers, Gujarat

No	Common Name of Species (Scientific Name)	Vishwamitri	Mini Nadi	Mahi	Vatrak	Sabarmati
	Family: Buonidae					
1	Common Indian Toad (*Duttapharynus melanostictus)*	P	P	P	P	P
2	Marbled Toad (*Duttapharynus stomaticus*)	--	--	P	P	--
	Family: Michrohylidae					
3	Painted Frog (*Kaloula taprobanica)*	--	--	--	P	--
4	Ornate Narrow-mouthed Frog (*Microhyla ornate*)	P	--	P	P	--
5	Marbled Baloon Frog (*Uperodon sytoma*)	P	P	P	P	--
	Family: Dicroglossidae					
6	Common Skittering Frog (*Euphlyctis cyanophlyctis*)	P	P	P	P	P
7	Six-toed Frog (*E. hexadactylus)*	--	--	--	P	--
8	Indian Bull Frog (*Hoplobatrachus tigerinus*)	P	--	P	P	--
9	Unidentified Cricket Frog *(Zakerana sp.)*	P	--	P	P	--
10	Indian Burrowing Frog (*Sphaerotheca breviceps*)	P	P	P	P	--
	Total No.	**8**	**4**	**8**	**10**	**2**

Appendix 2: List of sighted and recorded Reptilian species in 'Survey Blocks' of the five rivers, Gujarat

No	Common Name of Species (Scientific Name)	Vishwamitri	Mini Nadi	Mahi	Vatrak	Sabarmati
	Family: Crocodildae					
1	Mugger (*Crocodylus palustris*)	P	-	-	R	-
	Family: Bataguridae					
2	Indian roofed turtle (*Pangshura tecta*)	-	-	-	P	-
	Family: Trinychidae		-			
3	Indian soft-shell turtle (*Nilssonia gangeticus*)	-	-	P	R	-
4	Indian flap-shell turtle (*Lissemys punctata*)	P	-	P	P	-
	Family: Agamidae					
5	Garden lizard (*Calotes versicolor*)	P	P	P	P	P
6	Fan-throated lizard (*Sitana ponticeriana*)	P	P	P	P	P
	Family: Varanidae					
7	Bengal monitor (*Varanus bengalensis*)	P	P	P	R	P
	Family: Boidae					
8	Common sand boa (*Gongylophis conica*)	R	-	P	P	R
	Family: Colubridae					
9	Indian rat snake (*Ptyas mucosus*)	P	P	P	P	P
10	Ch. Keelback water snake (*Xenochrophis piscator*)	P	P	P	P	P
	Family: Elapidae					
11	Spectacled cobra (*Naja naja*)	P	-	P	R	R
	Family: Viperidae					
12	Indian saw-scaled viper (*Echis carinatus*)	P	-	-	P	R
	Total =	**9+1=10**	**5**	**9**	**8+4=12**	**5+3=8**

State. (P= Sighting in present study; R= reported of presence).

Appendix 3: List of sighted and recorded Mammalian species at five 'Survey Blocks of Five Rivers, Gujarat State.

No	Common Name of Species (Scientific Name)	Vishwamitri	Mini Nadi	Mahi	Vatrak	*Sabarmati*
	Family: Cercopithecidae					
1	Hanuman Langur (*Semnopithecus entellus*)	P	P	P	P	*P*
	Family : Sciuridae					
2	Northern Palm Squirrel (*Funambulus pennantii*)	P	P	P	P	*P*
	Family: Hystricidae					
3	Indian Crested Porcupine (*Hystrix indica*)		P	P	R	-
	Family: Leporidae					
4	Indian Hare (*Lepus nigricollis*)	-	P	P	P	-
	Family: Felidae					
5	Jungle Cat (*Felis chaus*)	P	P	P	R	-
6	Leopard (*Panthera pardus*)	-	R	R	-	-
	Family: Viverridae					
7	Asian Palm Civet (*Paradoxurus hermaphroditus*)	-	R	R	-	-
8	Small Indian Civet (*Viverricula indica*)	-	-	R	-	-
	Family: Herpestidae					
9	Grey mongoose (*Herpestes edwardsii*)	P	P	P	P	*P*
	Family: Hyaenidae					
10	Striped Hyena (*Hyaena hyaena*)	-	R	P	-	-
	Family Canidae					
11	Jackal (*Canis aureus*)	P	P	P	P	-
	Family: Bovidae					
12	Nilgai (*Boselaphus tragocamelus*)	-	P	P	P	-
	Total=	**5**	**8+3=11**	**9+3=12**	**6+2=8**	**3**

Notes:
-For all the appendices : P= Sighting in present study; R= reported of presence

-List of birds in the form of an appendix cannot be given due to lack of space. The same can be availed from the author (razoovyas@gmail.com)

Black Tern versus Whiskered Tern with 'Black Tern Patches' in Gujarat (India)

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ABSTRACT-Three species of terns belonging to the genus "*Chlidonias*" are often referred to as "Marsh Terns". As far as Gujarat (Western India) is concerned, the Whiskered Tern (*C. hybridus*), a resident-migratory species of the Indian subcontinent is the commonest one. However, a possibility of coming across the rarest of the rare Black Tern (*C. niger*), which is largely considered as 'vagrant' for the Indian Subcontinent cannot be ignored. As these terns mainly occur in Gujarat as wintering migrants, they are mainly seen in non-breeding plumage. As the non-breeding plumage of the two species has some overlapping plumage characters, they may lead to erroneous identification especially, if an observer is a novice. In October 2009, I had come across some individuals of 'marsh terns' in non-breeding or juvenile plumage that had overlapping characters with respect to *C. hybridus* and *C. niger.* Through literature survey and consistent email based communication with a marsh tern expert of an international repute, I have undergone some learning in distinguishing commoner Whiskered Tern in non-breeding and juvenile plumage from the rarest of the rare vagrant Black Tern (in non-breeding and juvenile plumage). This paper is written with an aim of sharing my learning with the readers of "Jalaplavit".

KEY WORDS: Black Tern, Breast-side smudges, Marsh tern, Whiskered Tern

INTRODUCTION

Black Tern(*Chlidonias niger*), White-winged Tern (*Chlidonias leucopterus*) and Whiskered Tern (*Chlidonias hybridus*) are referred to as 'Marsh Terns'; the small sized terns that breed on freshwater marshes and have varying degree of predominance of black plumage during breeding season.

Black Tern (*Chlidonias niger*) is a strongly migratory, Holarctic tern which is known to have two sub-species, namely *Chlidonias niger niger* (or Eurasian Black Tern) and *C.n. surnamensis* (North American Black Tern). Though Eurasia is conventionally known to have *C.n.niger,* a few records of *C.n.surinamensis also exist for the time-frame of* 1999- 2012 (McKerchar, 2013).*C.n.niger* is known to range from southern Scandinavia to southern Spain, east through Europe and western Asia to central Mongolia**.** Individuals from this area predominately winter on the Atlantic coast of Africa, from the Western Sahara to South Africa (Birdlife International, 2013)**.** It is known to occur in Russia, wherein its breeding and staging areas have been identified

(Delany *et al.,* 2006) and it has been included in Vol. 3 (year 1969) of "Birds of the Soviet Union" (Abdulali and Ambedkar, 1984). As far as India is concerned, Black Tern (*Chlidonias niger niger*) is considered a vagrant (Ali & Ripley, 1969; Kazmierczak, 2000, Alfred *et al.,* 2001;, Grimmett *et al*., 2011), very rare winter migrant (Kannan *et. al.,* 2001) or hypothetical (Rassmusen and Aanderton 2005) or non-existent (Harvey, 2013). There are only a few places from where this species has been reported. One of the authentic records is from the Point Calimere [a coastal site (I8'N; 79°51' E) in Tamil Nadu state, South India). P. B. Shekar, the Bombay Natural History Society's Field Assistant, had obtained a tern bearing Moscow ring marked Moskwa F-I40.956 and the U.S.S.R. Academy of Sciences by their letter No, 3450 dated 19th January 1972 said it had been placed on a juvenile *Chlidonias niger* at Artek, Krasnovodkii, Turkmen S.S.R., 37.21 N, 53.56 E, on 18th July 1970 (Abdulali and Ambedkar 1984). Abdulali and Ambedkar (1984) have also stated that the recovery of this individual of ringed Black Tern had definitely established the occurrence of the species in India. The Handbook of the Birds of India and Pakistan by Ali and Ripley (1969) has mentioned about the Black Tern sighting at Delhi in 1949 by H. G. Alexander that "Sight recorded near Delhi, 11 October 1949, with adequate corroborative evidence by an experienced observer familiar with the species in Europe (H. G. Alexander, JBNHS 49:12021). Confirmatory specimen required."Harvey (2013) has mentioned that Ganguli (1975) knew G. Alexander better than the authors of the Handbook and he opined that G. Alexander might have misidentified a White-winged Tern (*Chlidonias leucopterus*). S. Balachandran (Bombay Natural History Society) ringed several individuals of Black Terns between 1989 and 1991, during the BNHS Bird Migration Project (Balachandran, 1994); Kaliveli Lake (Tamil Nadu), and Pulicat Lake (Sriharikota, Andhra Pradesh), where 17 birds (Balachandran, 1994), and one individual (Kannan *et al*., 2009) were ringed respectively. However, Harvey (2013) had opined that Black Terns have never occurred in India and identification errors have occurred in the past as full range of the plumages of the other two marsh tern

species (*C. hybridus* and *C. leucopterus*) has not been appreciated sufficiently widely among observers. Apart from the Handbook that had included Black Tern as a Vagrant species for the Indian Subcontinent, several recent field-guides for the birds of Indian Subcontinent mention following status for Black Tern in India—Kazmierczack (2000): Vagrant; Grimmet *et al*. (2011); Vagrant; Rassmusen and Anderton (2005): Hypothetical.

Contrary to the Black Tern, the Whiskered Tern (*Chlidonias hybridus*) is a common resident-migratory marsh tern species of India/ Indian Subcontinent. For Gujarat state too, this is one of the commonresident-migratory wintering terns. Especially in Saurashtra region of the state, it is not an uncommon species in cold months though the species is known to breed in Kashmir and other parts of India (Dharmakumarsinhji, 1955).The Indian Whiskered Tern (*Chlidonias hybridus indicus*) differs from European and south-west Asian nominate races in having smaller wing (Ali and Ripley, 1969).

White-winged Tern (*Chlidonias leucopterus*) is the third species of 'marsh tern' that is migratory to India including Gujarat state. It is not as common as Whiskered Tern and can be considered to berare in India (Ali and Ripley, 1969) and Saurashtra (Dharmakumarsinhji, 1955), but it is not a vagrant as Black Tern.

This paper comprehensively discusses the plumage and other features (like bill) of some individuals of marsh terns photographed by the author. It is mainly aimed at proposing why few of these photographed individuals cannot be the non-breeding Black Terns (*Chlidonias niger*) despite having breast-side dark smudges and why a few others having breast-side smudges photographed at the same place and on the same date *(i.e.*, at Bhaskarpura freshwater marsh, Surendranagar district, Saurashtra region on 2 October 2009) are most likely the Black Terns. Apart from that, discussion has also been carried out about why another individual of the marsh tern photographed by a dedicated, experienced amateur bird enthusiast (Dr. Maulik Varu) on 31 August 2011 in

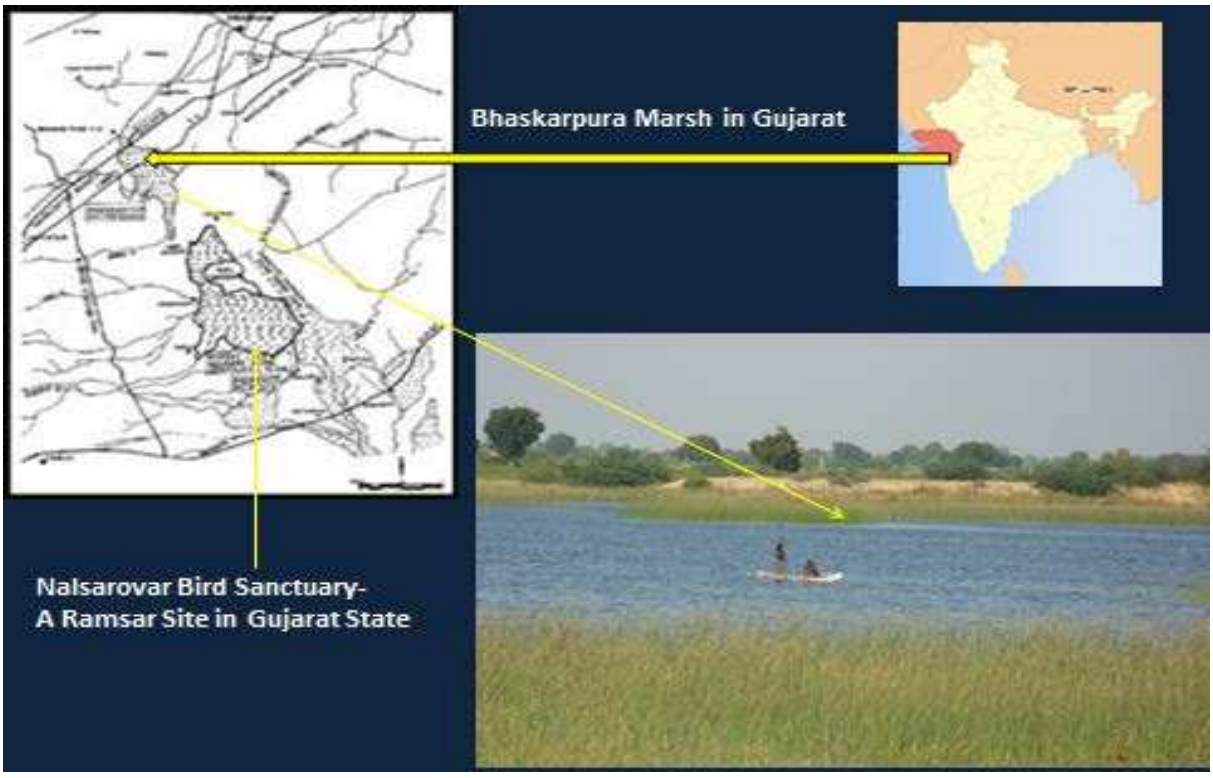
Bhavnagar city is most likely be a Black Tern in non-breeding plumage. Though the photographs were not taken with sophisticated DSLRs, they are of reasonable quality that would be helpful in *ex-situ* identification analysis using a computer. The discussion in this paper isnot just aimed at identification of each individual photographed, but also to compile, quote and analyze various marsh tern identification write-ups published in various research papers and authentic books. It is also aimed at conveying what other experts (especially, Jan van der Winden of the Netherlands) opined through personal communication about some of the photographed terns.

The Bhaksrapura Marsh Terns

The author visited an inland marsh at Bhaskarpura, near Vithalgadh village (22°59'22"N 71°58'33"E) in Lakhtar taluk (tehsil) of Surendranagar district (Gujarat) on 2 October 2009. This wetland is known as 'Bhaskarpura wetland' among the birdwatchers of northern Gujarat / Saurashtra, and is a designated Important Bird Area (IBA) (Islam & Rahmani, 2004). It is a largish shallow wetland having the depth of 50–75 cm (Anon., 1998) and it is located 24 km north-east of Lakhtar, and approximately 76 km south-west of Ahmedabad. It is located approximately 15 km from Nani Kathechi village, on the western shore of Nalsarovar Lake, which is a well-known bird sanctuary established in 1969 and the only Ramsar Site from Gujarat.

On reaching the wetland, he noticed that on its western side there was a long bund that separated it from adjoining cotton fields. Thus, on the western side of the bund, there was a cotton field, and on its eastern side, Bhaskarpura wetland. We walked on the bund for about 500 m, reaching a weir-like structure. On one side of the weir was the Bhaskarpura wetland with a lot of emergent aquatic vegetation (EAV) dominated by sedges (*i.e.*, plants of *Cyperaceae* family). On the other was a small, yet deep, pond that had emergent vegetation only along its edges, but had abundant submerged aquatic vegetation (SAV). This pond had a lot of fish of varying age, and size, *i.e.*, from fingerlings to adults. A thin film of water flowed continuously over the weir, from the large wetland

with abundant EAV to the small pond, a result of inflows from an 'escape' of a Narmada canal (Sardar Sarovar Project) that constituted the northern boundary of the large wetland. To his surprise, he found that a large number of fingerlings were swimming across the weir from the SAV-dominated pond to the larger wetland. This continuous movement of fingerlings attracted some terns that apparently included around five River Terns *Sterna aurantia*, and an equal number of smaller-sized marsh terns. Undoubtedly, a couple of the latter were Whiskered Terns *Chlidonias hybridus and they were photographed by me* using a digital camera (12x optical zoom, 6.1 MP res.) when they flew closer to the author.



Location of Bhaskerpura Marsh in Gujarat state, India and its View

A View of Mixed Flock of Foraging Marsh Terns and Indian River Terns, Bhaskarpura Marsh, 2 October 2009.

These individuals are shown in Figures 1a and 1b. However, a few marsh terns had dark patches on the sides of their necks, in front of the base of the wings (often referred to as breast-side patches or 'pegs'). Two of such individuals are shown in Figure 2a and Figure 2b. Like Whiskered Terns, they too were photographed with a digital camera (12x optical zoom, 6.1 MP res.) when they flew closer to me.

In the subsequent pages of this paper, the author has carried out a picture-wise discussion onidentification of the terns seen in each of the pictures that he took at Bhaskarpura wetland on October 2, 2010. The aim of the discussion is not only the correct identification of marsh tern species that were observed and photographed at Bhakarpura marshland on 2-10-2010, but to compile major literature available and its analysis.

Adult, non-breeding Whiskered Tern with Faint and Small Breast-side Smudges

Figure 1a: Lower bird- An adult Whiskered Tern (*Chlidonias hybridus*) in non-breeding plumage;

Fig. 1b (below Fig 1a): Another typical Whiskered Tern (*Chlidonias hybridus*) in non-breeding plumage Bhaskarpura Marsh, Surendranagar District, Saurashtra Region, Gujarat State (recorded on 2-10-2009).

Fig. 1a. Lower tern is an adult Whiskered Tern in non-breeding plumage with small, faint smudge and straight-looking, stouter bill; Upper tern is a moulting juvenile marsh tern as per Jan van der Winden. (Picture: Ketan Tatu)

Fig. 1b. An adult Whiskered Tern in non-breeding plumage with negligible smudges and straight-looking, stouter bill (Picture: Ketan Tatu)

Discussion on Identification of the Terns in Fig. 1a & Fig. 1b

Lower individualof marsh tern in Fig.1a: This is an adult individual of Whiskered Tern (*C. hybridus*) in non-breeding plumage. In this individual, following features are visible:

- Overall pale grey upper parts and white lower parts of the body
- Black cap on head, which does not extend downward on ear-coverts
- Breast-side smudge/ shoulder patch though present, it is quite faint and small
- Longish black bill that is almost straight and not slender
- Dark reddish legs

For a careful and concerned novice bird-observer, the presence of breast-side smudges/ shoulder patches, may lead to confusion in precisely distinguishing an otherwise Whiskered Tern from the Black Tern (non-breeding). This is because several field-guides/ handbooks that are widely used in India portray the breast-side smudges/ shoulder patches (or patches in front of the base of wings) as important field-marks that separate Black Tern from Whiskered Tern or White-winged Tern. Therefore, a novice and yet serious bird observer might get confused whether such an individual is an exceptional Black Tern. However, it may be emphasized here that though the lower tern (Whiskered Tern) in Fig. 1a has smudges in front of the base of the wings, they are small and faint. Such inconspicuous smudges in combination with other field-marks like 'non-slender', straight-looking bill, black cap not extending on ear-coverts and pale grey upper plumage are sufficient to decide that the individual in Fig. 1a is a Whiskered Tern. The significance/ non-significance of such inconspicuous smudges in the Whiskered Ternis discussed in the section of "review of literature about breast-side dark smudges".

An individual of marsh tern in Fig.1b: All the characters that were mentioned above for lower individual of marsh tern in Fig. 1a present in this non-breeding individual too. However, unlike in lower individual in Fig. 1a, the

boundary/ edge of the black cap is not straight, but somewhat 'concave'. In the lower individual in Fig. 1a, this boundary is straight, though with upward inclination from eye to nape. This shows that there can be minor variations even in otherwise similar looking adult individuals in non-breeding plumage. The difference also lies in the smudges as the one that is visible in the tern in Fig. 1b is even more inconspicuous (almost invisible) than that in the Whiskered Tern in Fig. 1a.

Considering other "Whiskered Tern" like features such as non-slender bill, pale grey upper plumage and black cap not extending down over the ear-coverts, even a novice bird field-ornithologist can understand that giving importance to presence of inconspicuous smudges in front of the base of the wings can lead to its miss-identification as Black Tern. Several field-guides/ handbooks widely available/ used in India do not mention this feature in non-breeding plumage of the Whiskered Tern.

A Moulting Juvenile Whiskered Tern with Small Yet Darker Breast-side Smudges

Figure 1c: A Juvenile Whiskered Tern (*Chlidonias hybridus*) moulting to first-winter plumage at Bhaskarpura Marsh, Surerndranagar District, Saurashtra Region, Gujarat State (recorded on 2-10-2009).

Discussion on Identification of the Terns in Fig. 1c

The tern in Fig. 1c is a moulting juvenile Whiskered Tern and it differs from those in Fig. 1a and 1b in the following manners:

- It has smudges in front of the base of the wings and these smudges, though small are darker than those in adult, non-breeding individuals in Fig. 1a and Fig. 1b. Despite the presence of conspicuous smudges, the individual in Fig. 1c is a juvenile Whiskered Tern moulting to first winter plumage and not a juvenile Black Tern. This is because vermiculated/ variegated feathers at the base of the upper surface of the left wing of the individual in picture

is typical of juvenile Whiskered. This is because each feather of the variegated plumage has blackish terminal edge. Moreover, unlike in a typical Black Tern, the grey wings are not dark enough to confirm this individual as a juvenile Black Tern.

- Black cap on head extends downward towards the ear-coverts but it does not sufficiently go down onto the ear-coverts as in a typical Black Tern.
- The bill does not look slender and sharp enough to identify the species as Black Tern.
- Browninsh (dark) sub-terminal band on the tail is more common plumage pattern in Whiskered Tern than in the Black Tern
- There is a conspicuous white collar in this individual, which is more common in Black Tern.
- but considering the variegated feathers at the base of the wings,

[It may be noted that the upper (farther) individual (in dorsal view) in Fig.1a too is none other than juvenile Whiskered Tern. As per Jan van der Winden (the Netherland): "This is a juvenile Whiskered Tern as the mantle has strong fringes, the size is comparable to the bird in front (which is surely a Whiskered Tern) and the wings are rather broad."]

Fig. 1c. Moulting Juvenile Whiskered Tern- moulting to first-winter plumage with smaller, yet darker smudges (Picture: Ketan Tatu)

Review of literature about breast-side dark smudges (or smudges in front of base of the wings or shoulder-pegs) in Whiskered Tern

In several field guides widely used for identifying birds of Indian Sub-continent[e.g., Peterson (1983), Kazmierczak (2000), Grimmett *et al.*, (2011)], the field-marks of the breast-side smudges are conventionally considered to be mostly associated with non-breeding or juvenile Black Tern (*Chlidonias niger*). In one or the other way, the field guides convey that the marsh terns other than Black Terns lack the breast-side smudges or if present, they are insignificant. For example, Kazmierczak (2000) has mentioned that Whiskered Tern can OCCASIONALLY have smudges on the side of the breast. But, the Olsen and Larsson (1995), one of the most renowned authorities on the subject, have mentioned that the Whiskered Tern's adult in winter plumage OFTEN with a faint greyish 'Black Tern patch' on the breast sides. They have also mentioned that the young Whiskered Tern probably MORE OFTEN have a dark 'Black Tern patch' on the breast sides, but it isgenerally weaker and paler than Black Tern's. Ali and Ripley (1969) though do not mention anything about presence/absence of faint or dark smudges in Whiskered Tern in winter plumage, they have considered the 'smudge' character to be important identification sign of the Black Tern in winter plumage. Thus, they mention that Black Tern in winter differs from the White-winged Tern chiefly by black of the hind head continuing as a dark patch on either side of neck in front of base of wings. Such an over-emphasis on breast-side smudges as an important field-mark for the identification of the Black Tern may create confusion for a novice birder. However, some published research papers from Europe, similar to Olsen and Larsson (1995) mention that such smudges may be present in Whiskered Tern too. Almström (1989) has stated that the breast of Whiskered is white, either unmarked or with a darker patch on the sides. This patch, however, if present, is usually not so large and distinct and probably never so dark as on Black Tern. Again, linking up the diffuse, paler and weaker smudges with Whiskered (or White-winged) Tern

may not be always advisable. This is because Williamson (1960) has mentioned: "Note, however, the warning that these (breast) patches vary in size and are not always at all conspicuous in the field". [However, Williamson (1960) has not discussed regarding presence/absence of breast-side smudges in Whiskered Tern.]In other words, like some Whiskered Terns, even Black Terns too can have inconspicuous smudges. Such being the case, it would be advisable for an observer that he/she does not rely only on the breast-side markings for reliable identification of a marsh tern when he/she comes across a marsh tern with faint or small or inconspicuous breast-side smudges. In other words, in such case, the observer should take into consideration breast-side smudges in combination with other features like plumage pattern on head, plumage colour of mantle, rump and tail and, perhaps, slenderness or stoutness of bill etc.

This photo of a Whiskered Tern with the breast-side smudge is adopted from **Almström (1989)**

211. First-winter Whiskered Tern *Chlidonias hybridus*, Spain, 5th October 1986 (*Ed Mackrill*). Note distinct dark patch on side of breast of this individual

[Source: Almström (1989)]

Review of literature about Head plumage of Whiskered Tern

As mentioned above, not just the breast-side plumage, but also the head plumage pattern can play an important role in correctly distinguishing a Whiskered Tern from other marsh terns, including the Black Tern.

Williamson (1960) mentions that all the three marsh terns have black or blackish brown "caps", with the crown generously flecked with white in the juvenile Whiskered and the hind-crown more uniformly blackish—though in the winter adult, this too is flecked with a certain amount of white. Almström (1989) for the Whiskered Tern in non-breeding (winter plumage) has mentioned thatin the 'Whiskered', the dark colour of the head does not project far below the level of the eye and the white on the sides of the head behind the ear-coverts does not reach very high up. Moreover, Almström (1989) also mentions that the crown in Whiskered Tern in winter is distinctly paler than on Blackand is streaked too. He however mentions that the dark behind eye does not extend downwards onto the ear-coverts as on juvenile Whiskered. Olsen and Larsson (1995), for juvenile 'Whiskered', have stated that the juvenile has head and underparts much as adult winter, but newly fledged young can have darker yet brown-toned crown and lores. Seen from behind, the nape is predominantly dark, without Black Tern's 'pony-tail' or whitish nape band. Olsen and Larrson (1995) have also stated that in Whiskered Tern's adult winter plumage, the 'cap' is more like winter plumaged Arctic or Common Terns rather than that of Black or White-winged Black Tern. However, rarely a weak dark ear spot can remain in adult Whiskered Tern in winter plumage.He also mentions that in the Whiskered Tern the black ear-coverts are joined to the black of thehind-crown and the space above is mottled with white, so that theblack appears as a C-shaped band.

Review of Literature about Whiskered Tern's Bill

Almström (1989) mentions that the Whiskered Tern hasusually has a noticeably heavier bill as compared to other two marsh terns. Williamson (1960) has stated that the bill of Whiskered tern, in comparison to that of the Black Tern, has straight bill (unlike slightly decurved bill in Black Tern) and in males it might be as long as its head, with pronounced goneys (i.e., The keel or lower outline of a bird's bill). However, Williamson (1960) and Olsen and Larsson (1995) caution that bill size may vary as per the

gender of the bird and Williamson (1960) also mentions that 'bill-size', is a character that can be best used to corroborate other field-characters.

Review of Literature on Other Body Plumage

'Saddle': The mantle is silvery-grey in adult Whiskered Tern in winter plumage as against dull grey in Black Tern (Williamson, 1960; Ali and Ripley 1969). In juvenile Whiskered Tern mantle and scapular (together-'saddle') arevariegated brown unlike dark brownish, non-variegated 'saddle' of juvenile Black Tern (Williamson, 1960).

Rump and Tail: On 'Whiskered', the rump is pale grey in both adult and juvenile (Williamson, 1960), whereas it is pale brownish-grey in both juvenile and adult 'Black'. As per Almström (1989) on Whiskered Tern back, rump and tail are usually concolourous, rather pale grey, although sometimes the rump is slightly pale. There is frequently a dark sub-terminal bar on the tail and outermost web of the outer tail-feather is white in Whiskered Tern. On the other hand, Black Tern has grey rump, upper tail-coverts and tail and dark sub-terminal bar on the tail is sometimes present (Almström, 1989).

Black Tern with large and/or Distinct Breast-side Smudges

Figure 2a (below): An individual that can best be considered as an adult/first winter/second winter Black Tern (*Chlidonias niger*) in non-breeding plumage; Bhaskarpura Marsh, Surendranagar District, Saurashtra Region, Gujarat State (recorded on 2-10-2010).

Figure 2b (below 2a): Another individual that can best be considered as an adult/first winter/second winter Black Tern (*C. niger*) in non-breeding plumage; Bhaskarpura Marsh, Surendranagar District, Saurashtra, Gujarat state (recorded on 2-10-2010).

Discussion on Identification of the Terns in Fig. 2a & Fig. 2b

The birds in the two pictures are the marsh terns that can best be considered as an adult/first winter/second winter Black Tern (*C. niger*) in non-breeding plumage. In these individuals, following features are visible:

- Overall grey upper parts that are darker than those of the individuals (non-moulting) of Whiskered Terns in Fig.1a and 1b
- Black cap on the head which, in comparison to the 'caps' of the non-moulting Whiskered Terns in Fig. 1a and 1b extending more downward below the eye
- Most importantly, the breast-side smudges/shoulder patches in the individualsin Figs. 2a and 2b are quite dark and large.
- Longish black bills in individuals in Figs. 2a and 2bthat are slenderer and more de-curved than those of the Whiskered Terns in Figs. 1a and 1b.

For any birder, observing marsh terns through a good pair of binoculars, the presence of large and dark (and not small and faint; as in case of some Whiskered Terns) breast-side smudges/ shoulder patches should be sufficient to enable him/her to identify the marsh terns as Black Terns. In this regards, the author had communicated with a Black Tern expert Jan Van der Winden of the Netherlands (who *regularly catches Black Terns to mark them as informed by Dr Taej Mundkur of the Wetlands International, the Netherlands)*. One of his replies pertaining to the individual in Fig. 2a was: "I have never seen Whiskered Terns with such prominent smudges on breast sides." Ian McKerchar of Manchester, UK had commented: "I have personally never knowingly seen breast 'pegs' looking quite so dark in Whiskered Tern as the ones in your images." Harvey (2012) has mentioned that in Black Tern the "patches" (i.e., smudges) are much more striking (than in Whiskered and moulting White-winged Terns)". Thus, if Harvey (2012) considers "striking" smudges as a reliable signs of Black Terns and if Jan Van der Winden and Ian McKerchar consider the smudges on the individual in Fig 2s to be exceptionally dark/prominent, then one should be convinced that the individual in Fig. 2a (as also in 2b having similarly dark and prominent smudges) is the Black Tern in non-breeding plumage. The photograph of the individual in Fig. 2c, that was recorded by Dr. Maulik Varu over a pond in a New Port area (9 km away from a coastal city of Gujarat

state, viz. Bhavnagar) was assessed by Jan van der Winden and he had opined that the bird in picture was definitely a Black Tern and apart from having very prominent blackish patch/smudge in front of base of the wing, typical head pattern and darker upper plumage (unlike paler-one in Whiskered Tern), the individual in the picture had the relative long slender bill compared to the bulky bill of a Whiskered. He also opined that the bird was a juvenile bird (first post fledging plumage) that clearly showed a rather extended black cap and no visible primary moult.

Fig.2a. A marsh tern in non-breeding plumage with large and strong breast-side smudges and de-curved bill that is not stout or heavy-Most likely; not a Black Tern like Whiskered Tern.

Fig. 2b.

Fig. 2c.

(Fig.2b. Another very likely Black Tern with very distinct breast-side smudge from Bhaskarpura marsh, Gujarat; Fig.2c: Another very likely Black Tern from Bhavnagar, Gujarat).

Review of literature on breast-side dark smudges (or smudges in front of base of the wings or shoulder-pegs) in Black Tern

Almström (1989) has stated that the underparts of Black Tern are white, with a large, distinct, dark patch on the sides of the breast. The flanks are sometimes mottled with dark (Note that on the individuals in Fig.2a and 2b, the patches are dark and prominent as mentioned earlier). Williamson (1960) has mentioned that the Black Tern has grayish brown smudges on the sides of the white breast, a downwards extensionof the plumage of the upper-parts, and these markings are diagnostic of this species in all the non-breeding plumages. Ali and Ripley (1969) have mentioned that in Black Tern in winter plumage, black of hind head continue as a dark patch on either side of neck in front of base of the wings.

Review of literature on Head Pattern in Black Tern

Harvey (2013) mentions that Black Tern of nominate (Eurasian) race ALWAYS show solid, unstreaked, black caps contiguous with larger, solid black cheek patches, extending well below the eye-lines in both immature and winter plumage. The author of this paper conveyed this opinion to Jan van der Winden, who, in turn replied that stressing that Black Tern should ALWAYS have a solid black cap is not always true, but there is much more variation. He also provided following picture as an example:

In this picture of Black Tern (provided by Jan van der Winden), the 'cap' is not solid black.

Review of literature on other body parts for Black Tern was also carried out by the author using Williamson (1960), Almström (1989) and Olsen and Larrson (1995). An interested bird enthusiast can also go through all this literature on internet and therefore it is not copied here. What is more important for the author (as also for the readers) is to know what the Black Tern expert Jan Van der Winden had mentioned about the Black Terns during different emails that he untiringly sent to me in response to my multitude of inquisitive emails. Jan's points about the Black Tern are as follows:

- If the picture of moulting Black Tern or Whiskered Tern is taken in October, the moult can't give us more information on species identification of a juvenile in moult as in October the Scheme of the two terns overlap too much
- If the mantle of the juvenile marsh tern is reddish brown and not the dark brown, then possibility is more of Whiskered Tern.
- If the tips of the tail of juvenile marsh tern are whitish and if there is sub-terminal bar on the tail, then the individual under observation is more likely to be the Whiskered Tern.
- White outermost web of the outer tail-feathers is known to be the identification mark of Whiskered Tern. But, the outer tail feathers might not be always visible well.
- So far, sightings in Gujarat indicate only irregular/incidental presence of Black Terns in this

region. It would be indeed interesting to find out if the region is used by this species on a structural basis. For this it would be good to check some coastal wetlands in September-October the coming years for real "flocks".

- The black patch on the breast is strong and large (in an individual in Fig. 2a) and I (i.e., Jan) never witnessed it as such in a Whiskered Tern. I see also a grayish tail and relative dark primaries. The bill indeed fits more in a Black Tern jizz. On the other hand the legs seem relatively long; but picture perspective may affect the appearance of legs' length. Most characteristics (in the marsh tern in Fig. 2a) point to a (juvenile/ 1w) Black Tern. In case of Black Tern, the migration route to India is indeed unlikely but not impossible for vagrants.

CONCLUSION

It is very likely that the marsh terns in Figs. 2a, 2b and 2c in this paper are Black Terns. Until some comprehensive studies are carried out on Whiskered Terns in India to understand their plumage changes and they prove that large and dark/ strong breast-side smudges can also occur on Whiskered Terns, we should not rigidly reject the possibility of occurrence of Black Terns in India as vagrant birds. Khacher (1996), in his ornithological overview for Gujarat mentioned that, "more intensive birdwatching may confirm that Gujarat is on itinerary of the migratory Black Tern (apart from Common Tern and Roseate Tern)." Under the influence of climate change too, a possibility of these terns migrating to India cannot be ignored.

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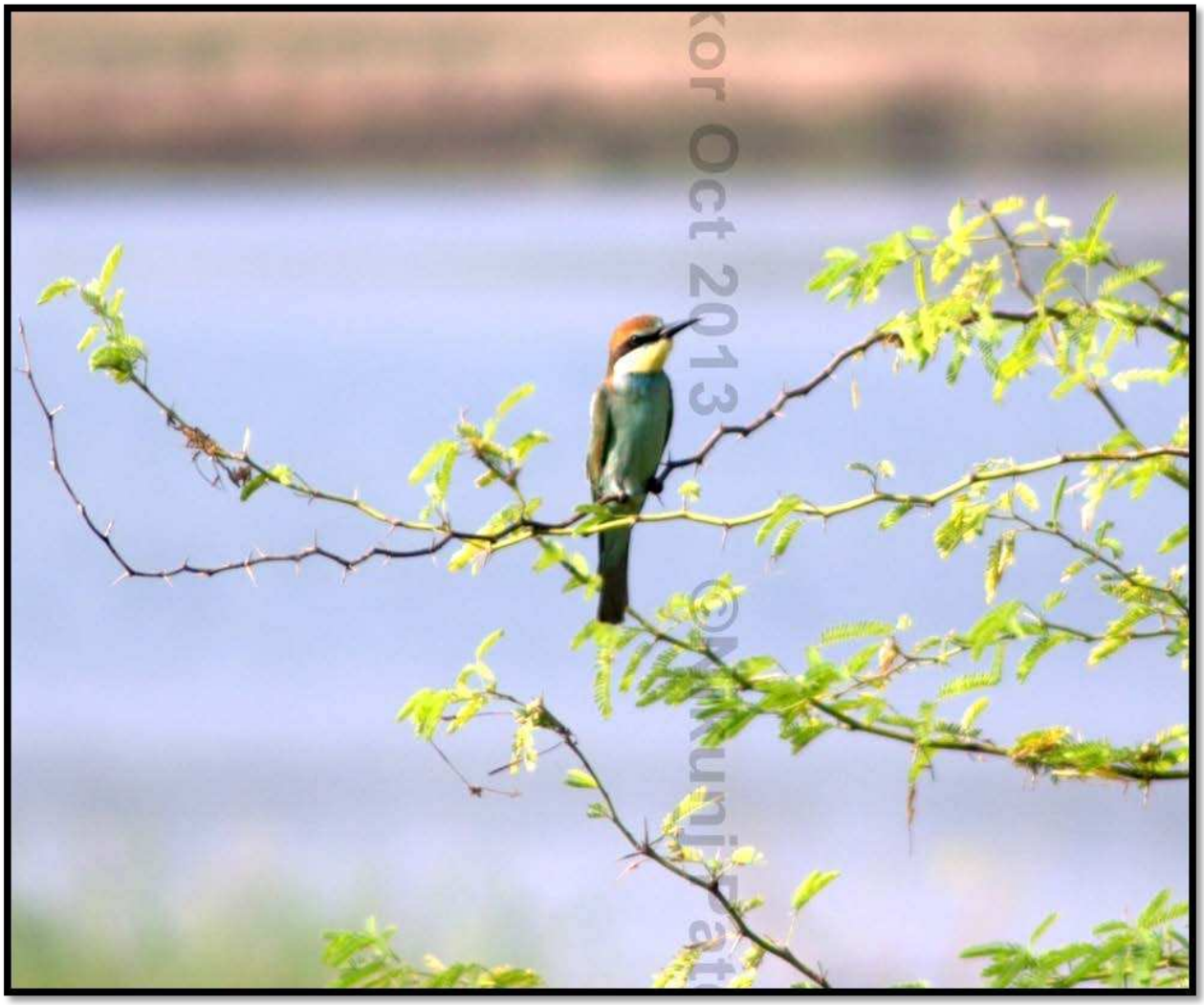
WETLAND BIODIVERSITY COMMUNICATIONS

[1]

Sighting of European Bee-Eater (*Merops epiaster*) in Surat, South Gujarat

Palak Thakor, Project Assistant, Project Mangroves, BNHS; "Prayas", Surat



European Bee-eater (*Merops epiaster*) recorded on 31-10-2013 at a Wetland of Tena Village near Surat (Photo: Nikunj Patel)

Wetland of Tena Village (N 21° 13' 42.6678", E 72° 40' 32.8218") is my favorite place for bird watching. It is located on the outskirt of Surat city of South Gujarat. In this village, there is a big lake-like wetland in the center of a farming area and on the other side of the village, there are several small and big water–logged areas created by high tide of the sea water.

On 31-10-2013, I visited the wetland with my friends Nikunj Patel and Bhairav for bird watching. While walking along a road adjacent to a waterlogged area, we saw a bee-eater sitting on a small *Prosopis juliflora*. At first I did not pay much attention considering it to be a Small Green Bee- eater. However, as we went nearer, I noted that its size was bigger and did not fall in the category of the birds known to me. So, I suggested Mr. Nikunj to take as many photographs as he could, so that based on the examination of the pictures, the bird could be properly identified. However, we could take only four photographs of the bird as just a few minutes later, the bird took flight only to rise high in the sky and disappeared in the northern direction. Then, I started matching its field characters in photographs taken by Mr. Nikunj with those in a standard field-guide. All the field characters in the photographs matched well with those shown for European Bee-eater (*Merops epiaster*). As I had not seen this species earlier, I showed its photographs to an experienced birdwatcher and my birding 'guru', Dr. Nilay Desai, who confirmed my identification. This is the first record of European Bee-eater in Surat City.

[In the Field-guide "Birds of the Indian Subcontinent" by Grimmett et al.(2011), the status of this bird in Gujarat state is shown with a yellow ring on Gujarat. It means that there has/have been isolated record/s of this species occurring as a passage visitor to Gujarat. The individual in the photograph lacks central elongated tail feathers and bright chestnut wing-coverts indicating that it might be a juvenile – F.Editor]

[2]

A Little Stint (*Calidris minuta*) with an Eye Problem, Surat, S. Gujarat

Palak Thakor, Project Assistant, Project Mangroves, BNHS; "Prayas", Surat

A Little Stint (*Calidris minuta*) with an eye-disease at a wetland in Surat in Nov. 2013 (Photo: Dr. Ankur Patel)

On 10-11-2013, Dr. Ankur Patel and I were birding in a coastal wetland area of Tena village on the outskirt of Surat (South Gujarat). Dr. Ankur Patel saw a Little Stint moving here and there in shallow water. He started photographing the bird. Later, he started getting closer to the stint, but it did not take heed of Dr. Ankur's proximity. He first thought that the bird was fearless or too confiding. However, after photographing the bird and examining its picture carefully after cropping, we came to know that it was having an eye problem-an infection. Thus, the bird was not fearless or confiding; it simply could not see Dr. Ankur standing in its proximity. Earlier, I had seen this kind of eye-infection in peafowls, in which, some of fluid kept coming out of infected eyes and after drying, it covered the eyes. But this was the first incident that we saw similar problem in a wader. After knowing that the bird was facing some eye-disease, we started taking note of it in other birds also. We saw same type of infection in a couple of stints after some days. Though due to considerable distance between the birds and us, we could not take photograph again, but we could certainly see their unhealthy eyes through a Spotting Scope.

[3]

Waterbirds Observed in Great Rann of Kachchh (GRK)

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Great Rann of Kachchh (GRK) is a saline desert-cum-seasonal saline wetland having a vast area of over 7,000 sq. km. It gets flooded between May and October when sea water driven by high winds and tides from the Arabian Sea and monsoon run-off from the hills of Gujarat and Rajasthan, mix together over the plains (Hussain and Roy, 1993). The depth of water varies from 0.5m to 1.5m. It is a part of Kachchh Biosphere Reserve and also protected by Gujarat Forest Department as Kachchh Desert Wildlife Sanctuary (Pandey, 2004).

Some opportunistic surveys to different regions of GRK were carried out in the form of frequent visits from September 2012 to March 2013. Birds were observed using pairs of 10 X 50 binoculars and they were photographed using a DSLR camera (Sony) with zoom lenses. The birds were identified using standard field guides of Balar (2007), Grimmett *et al*. (2011) and Ali (2012).

Total 45 species of birds were observed in the GRK, of which 21 species that are listed in Table-1 were waterbirds. Of these, 5 species were residents, 7 species were extra-limital migrants and 9 species were Resident-Migratory for the India subcontinent. Mallard, an uncommon migratory duck for Gujarat state was seen in good numbers (Fig. 1). White Storks, which is known to patchily occur in Gujarat was recorded in the GRK during our surveys (Fig.2).

Table 1: Waterbirds recorded in Great Rann of Kachchh (GRK)

Sr. No.	Common Name	Scientific Name	Status for the Indian Subcontinent
1)	Great Crested Grebe	*Podiceps cristatus*	RM
2)	Rosy Pelican	*Pelecanus onocrotalus*	RM
3)	Dalmatian pelican	*Pelicanus crispus*	M
4)	Little Egret	*Egretta garzetta*	R
5)	Western Reef Egret	*Egretta gularis*	RM
6)	Large Egret	*Casmerodius albus*	RM
7)	Cattle Egret	*Bubulcus ibis*	R
8)	White Stork	*Ciconia ciconia*	M
9)	Mallard	*Anas platyrhynchos*	M
10)	Gadwall	*Anas strepera*	M
11)	Common Teal	*Anas crecca*	M
12)	Greater Flamingo	*Phoenicopterus ruber*	RM
13)	Lesser Flamingo	*Phoenicopterus minor*	RM
14)	Common Crane	*Grus grus*	M
15)	Demoiselle Crane	*Grus virgo*	M
16)	White-bellied Sea Eagle	*Haliaeetus leucogaster*	R
17)	Black winged Stilt	*Himantopus himantopus*	RM
18)	Brown headed Gull	*Larus brunnicephalus*	RM
19)	Gull billed Tern	*Gelochelidon nilotica*	RM
20)	Pied Kingfisher	*Ceryle rudis*	R
21)	White breasted King-fisher	*Halcyon smyrnensis*	R

R-Resident, RM-Resident-Migrant, M- Migrant, (For the Indian Subcontinent). Birds like Blue-cheeked Bee-eater, though inhabit around welands, they are not considered here as waterbirds.

Fig. 1. Mallards in the Great Rann of Kachchh

Fig. 2. White Storks in the Great Rann of Kachchh

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An Unusual Mallard at Pariej Wetland, Kheda District, Gujarat

Jay V. Pagi & Harsh V. Pagi

Mallard (*Anas platyrhynchos*) is an uncommon winter migratory duck to Gujarat. This is a larger sized duck having length of about 23 inches. Males have glossy green head, narrow white collar, purplish brown breast, pale grey underparts, white tail with curled black central feathers, yellowish bill and orange legs. It has broad purple speculum (Peterson *et al.,* 1983: A Field Guide to the Birds of Britain and Europe, Croom Helm, London).

However, on 16 March 2013 at 6.30 pm, when we visited a famous wetland of Kheda district (Gujarat), namely, Pariej Irrigation Reservoir, we saw a male Mallard that had some unusual plumage pattern (see the picture above). It lacked the plumage colours discussed above. Rather, it had too much of white colour on different parts of early. Why such plumage?

This looks like a case of "LEUCISM" found in wild waterbirds and in many other animals. It is caused by a genetic defect resulting in faulty pigmentation in the skin and/or feathers. In leucistic bird, the normal plumage colour is either diluted or partially lost in 'white patches' (as in above pictures). Some people (wrongly?) call such birds – partially albino. **-- F. Editor**

Great Backyard Bird Count (GBBC)—India

The Great Backyard Bird Count (GBBC)--India is back! The dates are 14-17 February 2014. Join in this global birding event.

GBBC is a worldwide event. Last year birders from 111 countries took part, counting around 35 million individual birds of 4,000 species. Indian birders submitted 400+ lists of 500+ species. You can see a summary of the global results here and the India results here.

Go birding for at least 15 min, listing all the species you see, with rough count of each. It doesn't matter if you can't identify every single species -- what you can identify is good enough! Login to www.ebird.org and submit your species list.

More details at
http://www.birdsource.org/gbbc/howto.html

Contact: Dr. Suhel Quader (suhelq@ncf-india.org)