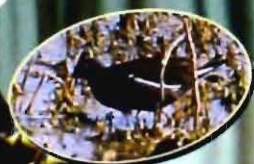


Wetland Ecosystem Series, 11

FAUNA OF NAL SAROVAR GUJARAT



SANJEEV KUMAR



ZOOLOGICAL SURVEY OF INDIA



Wetland Ecosystem Series, 11

Fauna of Nal Sarovar Gujarat

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Edited by the Director, Zoological Survey of India, Kolkata



**Zoological Survey of India
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FAUNA OF NAL SAROVAR, GUJARAT

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PREFACE

Fauna of Nalsarovar wetland is the outcome of the project undertaken to carry out the research work on the faunal diversity and ecology of wetland of national significance and an important bird sanctuary of Gujarat in India. The present publication describes the Nalsarovar wetland and its biodiversity under various subheads throwing light on Nalsarovar Lake, its status, history, climate, geology and hydrology, soil and habitat. A brief review of literature covers scientific research done by earlier workers. The physiographic features are described in limnology with plant life under flora. The fauna recorded from the Nalsarovar wetland is described in invertebrate fauna comprising of zooplankton and insecta. Vertebrate fauna deals with ichthyofauna, amphibian, reptilia, aves and mammalian species. Threats and conservation strategies are also discussed in brief in the last chapter. In all 410 species are reported in this book. The study apart from providing taxonomic account of the species recorded also provides information on its distribution in the Nalsarovar wetland along with the status. The documentation of various faunal species is supported by various maps, figs, tables and coloured photos and plates. Since, this important wetland of national significance is facing serious threats, I hope this book will not only serve as an important tool for drawing attention of policy makers in taking steps towards its conservation as an wetland of international importance for conserving the rich natural faunal heritage of Nalsarovar wetland, Gujarat, India but also to save this biodiversity hotspot for nature lovers, scientists and research students world over.

This book could not have been accomplished without the help rendered by many directly or indirectly. I take this opportunity to thank all of them here. I am thankful to Dr. Ramakrishna, Director, Zoological Survey of India, Kolkata and Dr. J.R.B. Alfred, Ex-Director, ZSI for giving me the opportunity to work on this wetland of National Importance. I am also deeply indebted to Dr. Q.H. Baqri, Scientist-F, Dr. N.S. Rathore, Scientist-E, the then Officer-in-Charges, Desert Regional Station, Z.S.I., Jodhpur for providing facilities, valuable suggestions and guidance all through the period of survey work.

I acknowledge my sincere thanks to the scientists of Zoological Survey of India who have identified the material and contributed descriptions in this publication. I am gratefully indebted to Late Dr. I. Prakash and Dr. R.C. Sharma, Professor of Eminence, DRS, ZSI, Jodhpur, for their constant encouragement and lucid suggestions. I am thankful to the staff of DRS, ZSI, Jodhpur in helping me to conduct survey work efficiently. I extend my thanks to various other organizations and individuals who helped me in various ways. I specially thank Smt. Seema Kumar, Scientist, AFRI, Jodhpur for identifying various insect groups. I also thank Shri Chandan Singh, Scientific Officer, Wetland Division, MoEF, New Delhi for help rendered in updating information to make this piece of work more valuable. I also acknowledge the assistance of Smt. Venulata Nigam for providing the valuable literature from the library, Shri

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Thanks are due to Shri Mahendra Gandhi and Shri Rohit Bhati, Jodhpur for assisting me in designing and type-setting of this publication. I finally express my thanks to Shri Rati Ram, Publication and Production Officer, ZSI, Kolkata for his sincere efforts in bringing out this publication. I am deeply indebted to my family members especially to my father who gave me scientific temper and to my son Sh. Mudit Kumar and little daughter Ms. Jayavidhi Kumar who bore all the absence of my attention during this period. I finally express my thanks to Almighty God especially Hinglaja Mata for giving me strength and devotion to successfully accomplish the project.

Place : Jodhpur
July, 2009

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1. INTRODUCTION

Wetlands are highly productive ecotones evolving out of land-water interaction. They are rated third among the highly productive ecosystem of the world and are generally eutrophic in nature i.e. they are rich in nutrients which support their high growth rates and thus rich in floral and faunal diversity. They perform a variety of ecological, hydrological and social-economic functions on the earth. Groundwater recharging, flood control, nutrient retention, fulfilling multifarious livelihood requirements of local human communities are some of the functions played by the wetlands in different parts of the world.

Till the decade ago wetlands in India had been totally neglected. They were cleared for agriculture or drained for urban housing and industrial development. The Government of India has made concerted efforts for wetland conservation by setting up an expert group for compiling information on the ecological status of the wetlands in the country. The initiation was made in the seventh plan for wetland conservation. The first step of the effort was to bring out a directory of the wetlands of India. The second step of the effort was to evolve area specific management strategies for selected wetlands. A national wetland committee was set up in 1987 consisting of experts on different disciplines for advising the Government on the selection of sites and drawing up conservation strategies. The terms of reference of the committee were:

- (i) To frame broad policy guidelines for implementing the programmes on conservation, management and research on wetlands;**
- (ii) To set up priority of wetlands for intensive conservation measures;**
- (iii) To monitor the implementation of programme for conservation management and research;**
- (iv) To advise on the preparation of inventory on Indian wetlands.**

This committee in the first stage selected ten wetlands for preparation of management action plan and in the second stage added six more wetlands. The 16 wetlands thus selected for evolving management strategies were :

- | | |
|------------------------------------|--------------------------------------|
| 1. Kolleru (Andhra Pradesh) | 2. Wular (Jammu and Kashmir) |
| 3. Chilika (Orissa) | 4. Loktak (Manipur) |
| 5. Bhoj (Madhya Pradesh) | 6. Sambhar (Rajasthan) |
| 7. Pichhola (Rajasthan) | 8. Ashtamudi (Kerala) |
| 9. Sasthamkotta (Kerala) | 10. Harike (Punjab) |
| 11. Kanjli (Punjab) | 12. Ujani (Maharashtra) |
| 13. Sukhna (Chandigarh) | 14. Renuka (Himachal Pradesh) |
| 15. Kabar (Bihar) | 16. Nalsarovar (Gujarat) |

Out of these sixteen selected wetlands eleven have attained the status of wetland of

international importance as Ramsar sites (Anon, 2006). Nalsarovar is yet to attain the status of Ramsar site of international importance inspite of being India's largest shallow water, natural lake harbouring rich waterfowl diversity and density. At present 94 wetlands including Nalsarovar have been identified under National Wetland Conservation and Management Programme (NWCMP) of India (Appendix-I).

Remote sensing has emerged as an important tool for mapping and monitoring habitat types or structural components in wetlands (Garg, 2002a). A number of studies have been carried out world over for wetland inventory (Garg, *et al.* 1998) and habitat suitability analysis for various waterfowl. Ministry of Environment and Forest (MoEF), Govt. of India, have carried out wetland inventory of India using Indian Remote Sensing Satellite (IRS) data of 1992-1993 time frame under a sponsored project 'Nation-wide Wetland Mapping' (Garg *et al.*, 1998). Temporal studies of 21 wetlands including Nalsarovar, identified by MoEF for priority conservation were carried out using multirate satellite data thus laying down firm foundation for wetland conservation and management (Garg, 2002b) (Fig. 1&2).

The Great Rann of Kachchh and Little Rann of Kachchh, Nalsarovar, Khijadiya, Thol, Pariej and Kanewal are some of the important and well-known wetlands in the State.

Besides, there are numerous unprotected marshes, village ponds, countryside ponds, irrigation reservoirs, lakes, paddy fields, canals and rivers in the state, which have been performing various ecological and hydrological functions. Apart from playing ecological roles, the lakes (jheels), ponds (talavs), dams, seasonal water bodies, paddy fields, streams, marshlands, coastline, mangroves, coral reefs, estuaries and large stretches of mudflats etc. contribute significantly to make this land rich in biological heritage. They also enrich habitat diversity, which results into rich wetland biota, including colourful bird life, fishes and aquatic flora. Gujarat is predominantly well placed among all the states as far as wetlands in India are concerned.

Gujarat has 36% of the total wetland area of the country. It has few unique wetlands in its four different regions (Table 1). Wetlands smaller than 56 ha are not included in the table. Kachchh is geographically the largest region with highest percentage of total wetlands. Out of the 831 wetlands in the state, 438 are coastal and 393 are inland wetlands (including 231 small and big reservoirs).

Table 1. Wetlands in different regions of Gujarat

Region	No. of Wetland	Area (km ²)*	% Area Wetland
North Gujarat	159	1,107	4.08
Kachchh	258	21,772	80.12
Saurashtra	352	2,598	9.56
South Gujarat	62	1,698	6.24
Total	831	27,175	100

As per study conducted by Space Application Centre, (ISRO), Ahmedabad, the area under inland wetlands is 2,092 km² and that of under the coastal wetlands has been 25,083 km² in

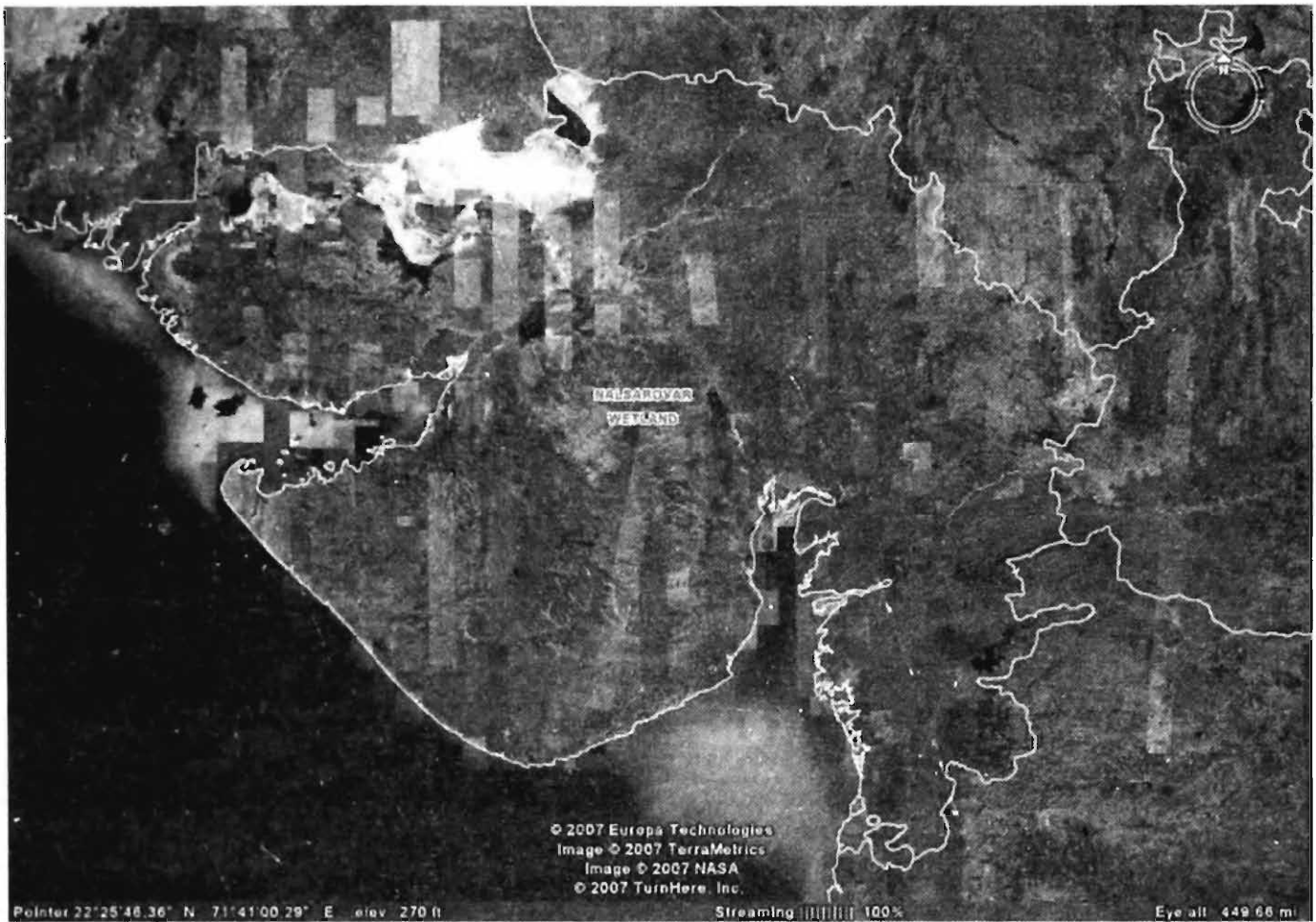


Fig. 1 : Location of Nalsarovar Wetland, Gujarat as seen in Imagery (March, 2007)

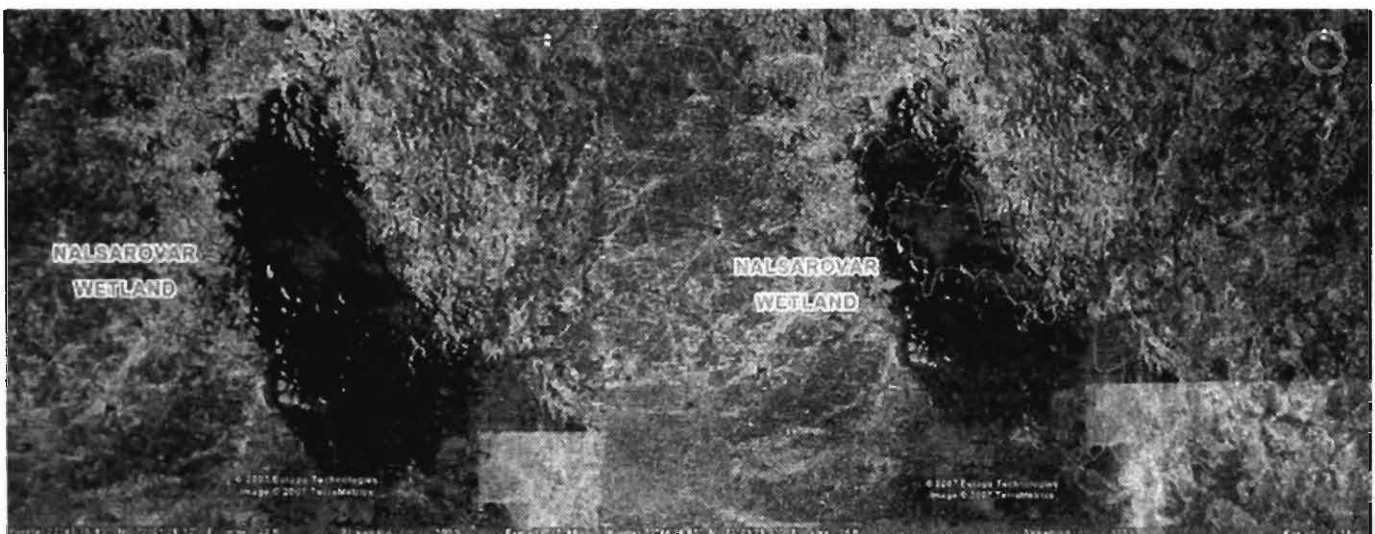


Fig. 2 : Nalsarovar Wetland, Gujarat as seen in Imagery (March, 2007)

the State (Garg, *et al.* 1998; Singh, 1998). In Gujarat, the coastal and inland wetlands cover 92.3% and 7.7% of the total wetland area respectively (Table 2). This indicates that the large area is under wetland in the state and encompasses almost all kinds of habitat in its region with largest coastline of the country falling in the category of coastal wetlands. Area up to six meter deep of the coast and the mangrove zone are the most important habitat of the wetland in the state.

Table 2. Inland and Coastal Wetlands in Gujarat

Inland Wetlands	Area (km ²)	Coastal Wetlands	Area (km ²)
Natural lake	154	Mangroves	1,031
Water logged	289	Coral reefs	130
Reservoirs	1,394	Mudflat	21,954
Tanks/ponds	198	Salt pans	460
Marshland	57	Other	1,508
Total	2,092	Total	25,083

There are three ox-bow lakes/cut-off meanders, one in each districts of Ahmedabad, Kheda and Mehsana. North Gujarat has all categories of wetlands except marsh/swamp vegetation. A large area is under mudflats. North Gujarat's proximity to the Gulf of Kachchh and its desertic conditions has helped in the formation of mudflats. Dharoi is one of the largest dams situated in this region. Saurashtra has mostly coastal wetlands. South Gujarat is bestowed with rivers Tapi, Narmada and the Mahi. Wetlands are mostly reservoirs and mudflats.

There are 21 important wetlands in Gujarat as per Directory of Indian wetlands, Hussain and Roy (1993) Nalsarovar is one of them. The name of the wetland, its area and the significant fauna and associated flora is given in Table 3.

Table 3. List of Important Wetlands in Gujarat and their significance

S.No.	Name of Wetland	Area	Significance
1.	Ajwa Lake	200-300 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowls (Duck <i>Fulica atra</i>). ■ Marsh Crocodile. ■ Rich aquatic vegetation: <i>Ammania baccifera</i>, <i>Chara</i>, <i>Potamogeton</i>, <i>Nymphaea</i> etc.
2.	Wetlands of Central and Eastern Saurashtra (more than 1000 wetlands)	About 2800 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowls. ■ Variety of Sedges and grasses formed a broad margin with extensive reed-beds, now absence of vegetation at most places.

Table 3. Contd.

S.No.	Name of Wetland	Area	Significance
3.	Fadvel Tank	Data Deficient	<ul style="list-style-type: none"> ■ Waterfowls (Pintails, whistling Teals). ■ Rich in Kevda
4.	Falzar Dam Reservoir	290 ha	<ul style="list-style-type: none"> ■ Migratory Waterfowl (Demoiselle Crane, Common Crane, Dalmatian Pelicans). ■ No information.
5.	Southern Gulf of Kachchh Marine National Park Marine Sanctuary	735000 ha 16289 ha 45592 ha	<ul style="list-style-type: none"> ■ Coral Reefs fauna, invertebrates, fishes, birds, reptiles and mammals. ■ Best Mangroves
6.	Hamirsar Tank	Data Deficient	<ul style="list-style-type: none"> ■ Migratory Waterfowl. ■ Neem and old Banyan trees.
7.	Wetlands of Kachchh Peninsula	5 ha to 1000 ha in a region of 1500,000 ha	<ul style="list-style-type: none"> ■ Migratory Waterfowl mainly Anatidae. ■ <i>Tamarix dioica</i>, <i>Salvadora</i> sp. <i>Calotropis procera</i>, <i>Typha</i>.
8.	Kaneval Reservoir	1500 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowls holds significance when Nalsarovar dries. ■ Aquatic vegetation : <i>Typha</i>.
9.	Kankavati Dam	435 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowl, especially Demoiselle crane.
10.	Gulf of Khambhat	At least 30,000 ha of wetlands; total area 400,000 ha	<ul style="list-style-type: none"> ■ Waterbirds and reptiles. ■ Trees of <i>Avicennia marina</i>
11.	Khijadiya Lakes Khijadiya Bird Sanctuary	1000 ha 604.9 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowls ■ Endemic <i>Cyperus dwarakensis</i> and <i>Tephrosia jamnagarensis</i>
12.	Nalsarovar Lake Nalsarovar Bird Sanctuary	11500 ha 12082 ha	<ul style="list-style-type: none"> ■ Wide variety of Waterfowl, Indian wild ass, nilgai and blackbuck. ■ <i>Chara</i>, <i>Nymphaea</i>, <i>Tephrosia purpurea</i>, <i>Salvadora</i> sp., <i>Prosopis</i> sp., <i>Acacia nilotica</i>.

Table 3. Contd.

S.No.	Name of Wetland	Area	Significance
13.	Nanda Islands	5000 ha	<ul style="list-style-type: none"> ■ Migratory birds, Indian Wild Ass ■ <i>Prosopis juliflora</i>, <i>Salvadora oleoides</i>, <i>S. persica</i>, <i>Capparis aphylla</i> and <i>Melia azadirachta</i>.
14.	Pariej Reservoir	500 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowls ■ Holds significance when Nalsarovar dries. ■ Aquatic vegetation : <i>Typha</i>.
15.	Pavagadh Lake	100 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowls, Marsh crocodiles. ■ Rich aquatic vegetation: <i>Ammania baccifera</i>, <i>Chara</i>, <i>Potamogeton</i>, <i>Nymphaea</i> etc.
16.	Great Rann of Kachchh	700,000 ha	<ul style="list-style-type: none"> ■ Important refuge of Indian Wild Ass (<i>Equus hemionus</i>), Chinkara (<i>Gazella dorcas</i>), Wolf (<i>Canis lupus</i>), Avian species. ■ <i>Acacia nilotica</i>, <i>Capparis sp.</i>, <i>Salvadora persica</i>, <i>Tamarix dioica</i>, <i>Avicennia alba</i>, <i>Cenchrus ciliaris</i>, <i>C. setigerus</i>, <i>Panicum antidotale</i>, <i>Dichanthium annulatum</i>.
17.	Little Rann of Kachchh	495,300 ha	<ul style="list-style-type: none"> ■ Indian Wild Ass, Nigai, Chinkara, Blackbuck, Wintering waterfowls. ■ Xerophytic shrubs and thorny scrubland, <i>Acacia nilotica</i>, <i>Prosopis spicigera</i>, <i>Salvadora persica</i> and <i>S. oleoides</i>, <i>Tamarix dioica</i>, <i>Suaeda fruticosa</i>, <i>Salsola barysoma</i>, <i>Haloxylon salicornicum</i>, <i>Cenchrus setigerus</i>, <i>C. ciliaris rotundus</i>, <i>Sporobolus marginatus</i>.

Table 3. Contd.

S.No.	Name of Wetland	Area	Significance
18.	Wetlands of Sabarkanta and Banaskanta District	Data Deficient	<ul style="list-style-type: none"> ■ Avian species. ■ Teak, Mango, <i>Prosopis juliflora</i>, <i>Acacia arabica</i>, <i>Melia azadirachta</i>, <i>Salvadora persica</i>, <i>S. oleides</i>, <i>Capparis aphylla</i>, <i>Zizypus</i> sp.
19.	Sapda Dam	193 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowl, especially Demoiselle crane. ■ No natural vegetation.
20.	Surendranagar Reservoir	Data Deficient	Data Deficient
21.	Vadhvana Lake	400 ha	<ul style="list-style-type: none"> ■ Wintering Waterfowls. ■ Rich aquatic vegetation: <i>Ammania baccifera</i>, <i>Polygonum plebeium</i>, <i>Chara</i>, <i>Nymphaea</i>, <i>Wolffia</i>, etc.

Waterfowl concentration in Gujarat during winters is one of the highest in the country as the area falls on the migratory route of birds. Migratory birds from Europe and Asia pass through the western part of the country to the Indian subcontinent and enjoy the varied habitats in Gujarat. Many species continue to stay in Gujarat for the entire winter season and some move on to the Deccan plateau. During their return in March and April, the migratory birds tend to stay at these wetlands for sometime before their departure from the country to their native places.

Besides spectacular bird fauna of wetlands, Gujarat the westernmost state of the country has many unique wildlife species. It is the last home of Asiatic lion and Indian wild Ass. India's first Marine National Park was established in Gujarat by State Government.

Gujarat has five important bird sanctuaries, Nalsarovar Bird Sanctuary being one of them Israel and Sinclair (1989) & Java (1991). The other bird sanctuaries are Thol, Khijadiya, Porbandar and Gaga Great Indian Bustard Sanctuary.

2. STUDY AREA

2.1 Nal Sarovar Lake

Nalsarovar, is a typical natural largest shallow water lake in India. This fresh water lake has an area of 120.82 sq. km. Nalsarovar is located between latitude 22°78 N to 22°96 N and longitude 71°92 E to 72°64 E on the junction of Saurashtra Plateau and mainland of Gujarat amidst the semi-arid lands of Ahmedabad and Surendranagar districts, about 65 km away from Ahmedabad, 90 kms from Gandhinagar, 82 kms from Surendranagar and 160 kms from Vadodara.

Biogeographically the protected area (PA) falls in 4B Gujarat-Rajwara biotic province of the semi-arid biogeographical zone, in the Districts of Ahmedabad and Surendranagar, as per the classification developed by WII, India, 1998 (Fig. 3). Wasteland and cultivated field constitute the boundary of the PA.

The lake basin is elongated and nearly elliptical in shape with gentle slope. Nalsarovar is a natural very shallow lake having maximum depth of about 1.5-2.0 meters when flooded. Maximum water depth at certain places is upto 180 cm during good rain year. The lake has about 360 odd islets or 'bets' or 'Thaliyas' most of which are located on the western boundary. They get exposed when water level recedes. Out of this, only 36 islets are having sizeable plateau like area, while the rest are very small (Fig. 4). List of thirty six prominent bets is given in Table 4. S. No.* corresponds to name of the bets and their location shown in fig. 4. Dharabla, has moderate tree cover of *Salvadora*, *Acacia nilotica* and *Prosopis juliflora*. Rests of the bets have scanty vegetation. These bets serve as habitat for faunal diversity.

2.2 Status

- Largest bird sanctuary in the country popularly known as Nalsarovar Bird Sanctuary formed in 1969 with an area of 115 sq. km.
- One of the 16 important wetlands identified by National Committee on Wetland for intensive conservation.
- Nalsarovar Wildlife Sanctuary Important Bird Areas (IBA) Site code : IN-GJ-09.

Year	Status	Area
1969	Nalsarovar Bird Sanctuary	115 sq. km
1982	Nalsarovar Bird Sanctuary	120.82 sq. km (+ 5.82 sq. km in previous area)
1993	Wetland of National Importance	120.82 sq. km
2004	Nalsarovar Wildlife Sanctuary Important Bird Areas (IBA) Site code : IN-GJ-09	12,082 ha

The Nalsarovar bird sanctuary area was declared in two phases. 115 sq. km area was declared as a sanctuary in 1969 and another 5.82 sq. km was added in 1982. Thus a total of 120.82 sq. km area is notified as sanctuary under the Wildlife (Protection) Act, 1972. Nalsarovar has been selected as important bird area (IBA) site mainly on the basis of congregatory criteria (A4) as more than 20,000 waterfowl are found when rainfall is normal. As the area is vast, so species-wise population estimates are not easy. Nevertheless, many ducks and waders are found in much larger numbers than their 1% biogeographic population threshold estimated by wetlands International (2002). Over 2, 24, 000 birds were recorded in 1992 and over 1,41,000 birds in 1996 census conducted by the Forest Department (Singh, 2001).

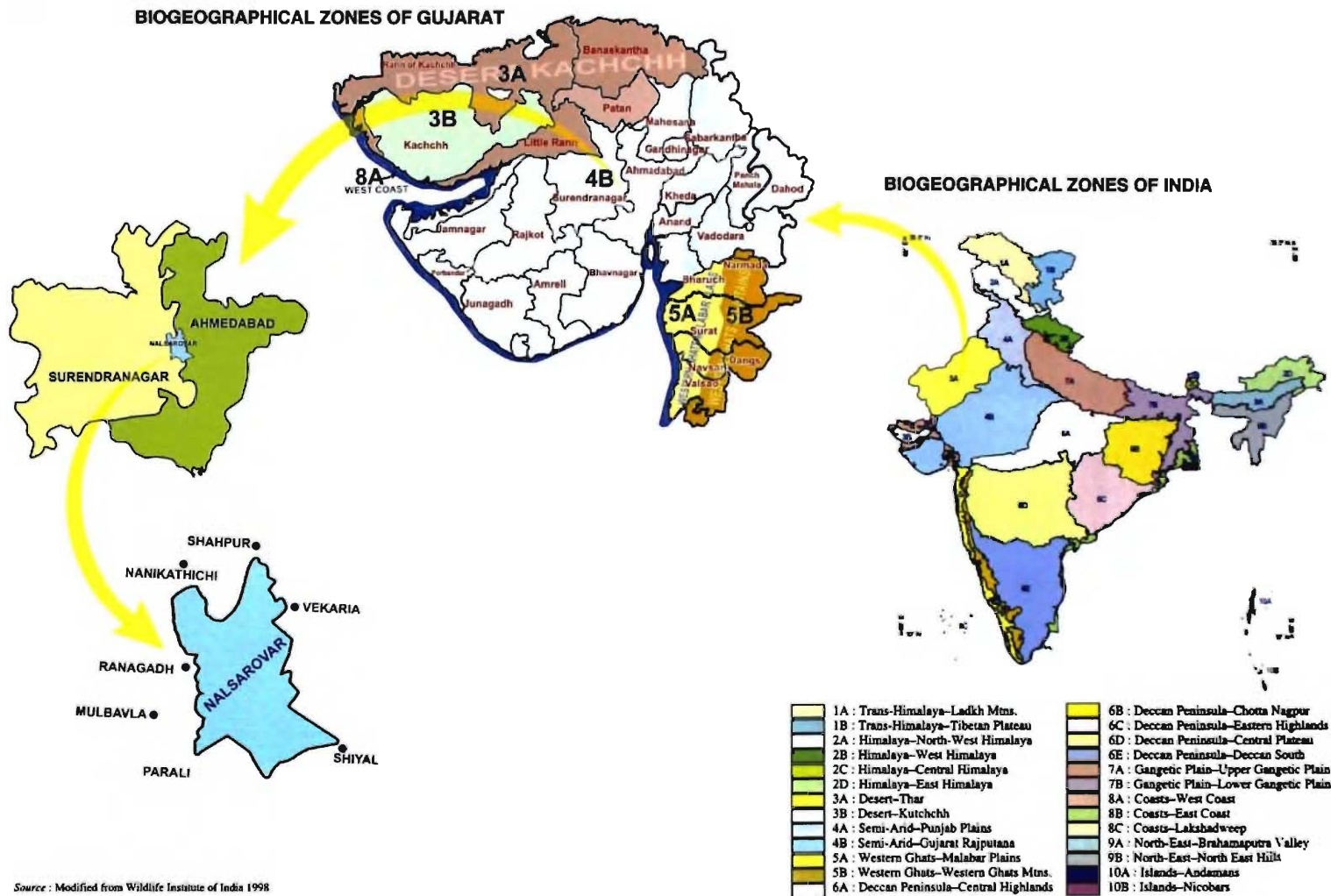


Fig. 3 : Location of Nalsarovar Wetland in Biogeographical zones, Gurajat, India

Table 4. List of Thirty six prominent bets in the Nalsarovar wetland, Gujarat.

S. No.*	Name of the Bet	S. No.*	Name of the Bet
1.	Chorathali	19.	Wagharithali
2.	Bendi	20.	Vanela
3.	Dhrabala	21.	Lambithali
4.	Borathali	22.	Revali
5.	Kanthali	23.	Naninal
6.	Panwad	24.	Motinal
7.	Mota Chera	25.	Zopala
8.	Nana Chera	26.	Jalamada
9.	Dandi	27.	Bajoth
10.	Bhankha	28.	Sansabid
11.	Dhankia	29.	Chhotiyala
12.	Moti Borad	30.	Vanhoti
13.	Lhasa	31.	Jambuthali
14.	Mandwada	32.	Shiyal
15.	Gadhevada	33.	Moti Ramada
16.	Kotharia	34.	Nan Ramada
17.	Panhoti	35.	Limasi
18.	Jamadia	36.	Surbet

* S. No. marked in the Fig. 4. as corresponding name of the bets

The sanctuary is a non-forest area and surrounded by Shahpur village in Viramgam taluka of Ahmedabad district in north; village boundaries of Shiyal in Dholka taluka of Ahmedabad district in south; village boundaries of Kayla and Vekaria of Viramgam taluka and Meni and Durgi villages of Dholka taluka of Ahmedabad district in east and village boundaries of Digvijaygadh, Panali, Mulbavla, Ranagadh, Bhagvanpur, Galiela and Nani Kathechi in Limbdi taluka of Surendranagar district in the west.

There are 12 villages on the boundary of the sanctuary with total population of about 34000. 'Padhar', the only tribal community in Gujarat living in plains, constitutes 42.3% of total population. Apart from 'Padhar', local people belong to 'Koli Patels' and 'Sindhi' Local community is economically dependent on Nalsarovar for various purposes fish, fodder, grazing and other employment. Fishery is one of the main occupations of people living on periphery of the Nal.

All around the basin, there is sandy to clayey shoreline which is mainly barren and support migratory cranes. The edge between the shore land and the open water area provides

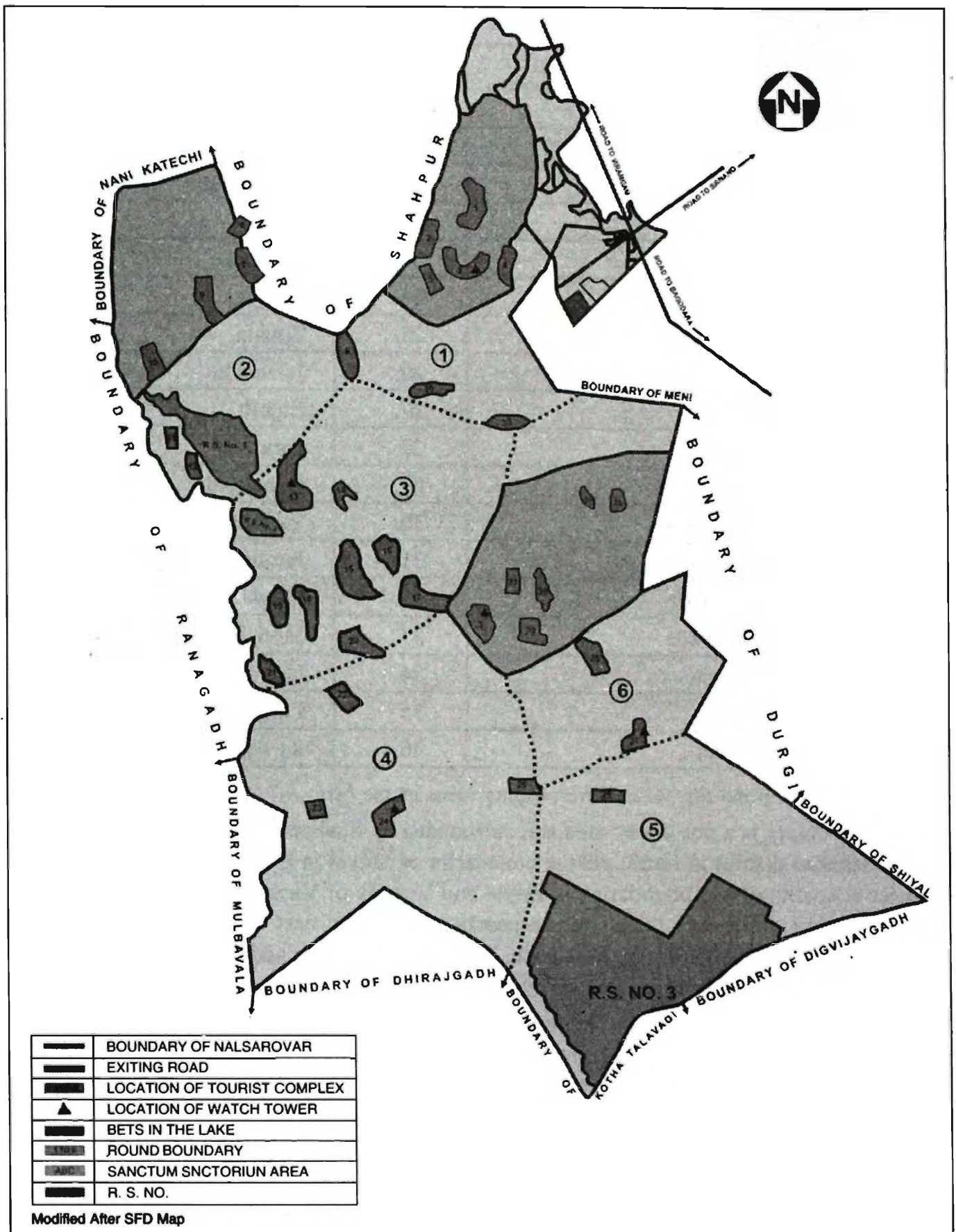


Fig. 4 : Map of Nalsarovar Wetland, Gujarat

feeding and resting ground to a large number of avian species. The agricultural fields in the lake environs also attract a number of avian species which are considered a menace by the inhabitants and hence they try to get rid of them.

2.3 History

The name nal seems to be derived from the name of king "Nal" known for his honesty and truthfulness. Some says that the word "Nal" (Naal) signifies the presence of a sea creek or a connecting link between the Gulf of Kutch and the Gulf of Cambay. Locally Nal is used for a canal like protrusion of a creek or river. This meaning seems more logical by Prasad *et al.*, (1997) who attempted to study the evolution pattern of the Nal lake.

2.4 Climate

The climate of the area is arid to semi-arid type. The temperature rises to a maximum of 45°C in May and minimum of 7°C in January. The rise in the temperature after peak winter accelerates the rate of evaporation of lake water that dries up rapidly. The lake has no weather station of its own for recording the seasonal climatic changes at Nalsarovar. The data available for Sanand, nearest place to Nalsarovar is taken as standard data for Nalsarovar bird sanctuary.

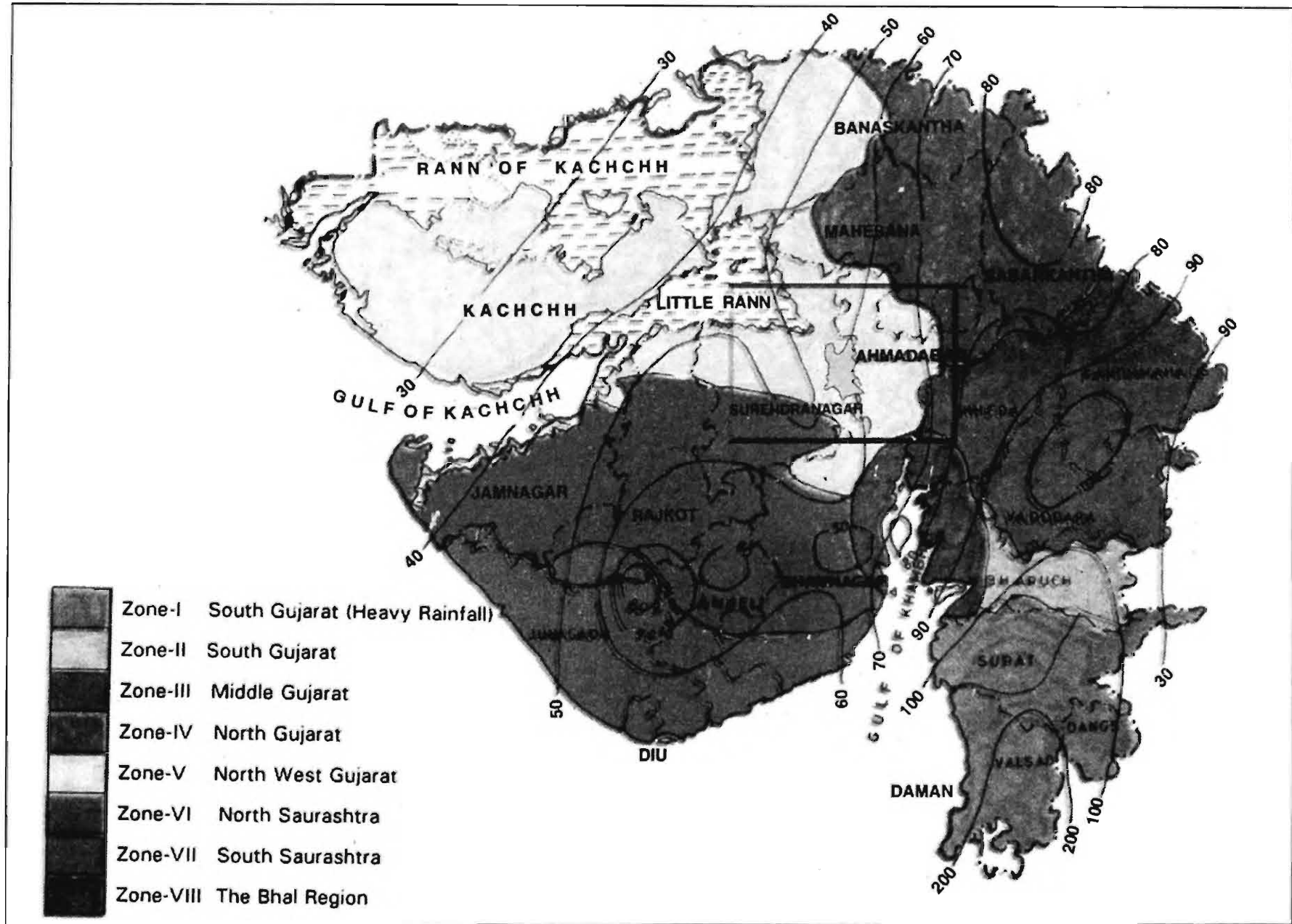
Rainfall occurs from June to September. However, most of the precipitation is recorded during months of July and August. The average rainfall in the area is about 580 mm. Wind is an important climatic factor determining the rate of evaporation of water in this area especially in summer when wind velocity is as high as 60 km/hr (Fig. 5).

Summer	:	Minimum temperature	30°C
		Maximum temperature	45°C
Winter	:	Minimum temperature	7°C
		Maximum temperature	22°C
Rainfall	:	Annual	580 mm

2.5 Geology and Hydrology

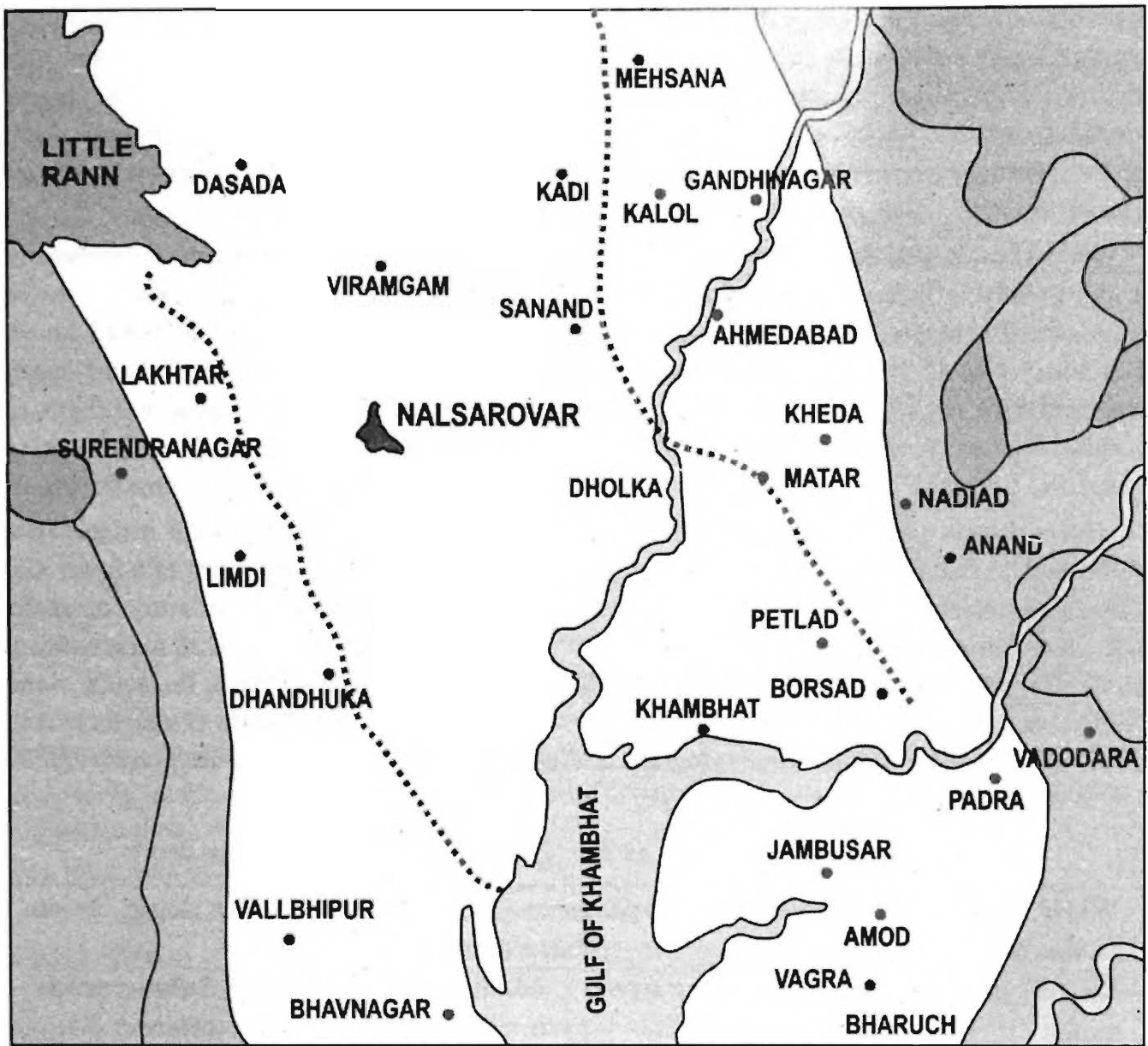
Nalsarovar is a seasonal water wetland of Lacustrine type. The nal region is a low lying area between the plains of central Gujarat and eastern Saurashtra. Owing to its low lying topography, it is believed to represent a filled up sea link, that previously existed between the little Rann in the north and the gulf of Khambhat in the south.

A three stage model for the evolution of Nal during lake quaternary period was developed by Prasad *et al.* (1997). Accordingly, during stage-I of evolution, spanning the period of 127-73 ka, a shallow sea linked the Gulf of Kachchh with the Gulf of Khambhat. The sea connection broke up around the beginning of marine isotope stage-4 due to regression of the sea. Subsequently only a land link remained. In stage-2 (73-7 ka), fluvial sediments from east



Source : Modified from Gujarat Ecological Commission 1996

Fig. 5 : Map showing Agro-climatic Zones and Rainfall Pattern of Gujarat Inset Surendranagar and Ahmedabad Districts.



Modified from GEER, 1968

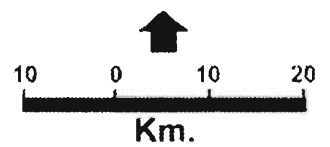
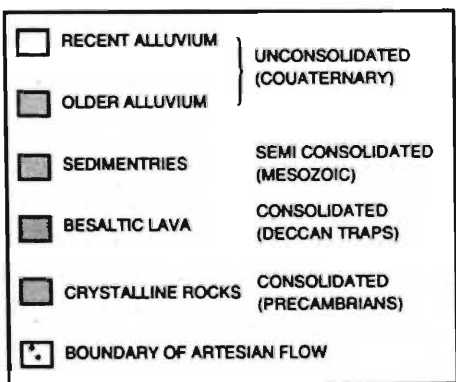


Fig. 6 : Geohydromorphological features around Nalsarovar Wetland, Gujarat

were episodically deposited in the Nal region in response to westward migration of depositional front of eastern rivers. In stage-3, due to advance of sedimentation front, tectonic and post glacial sea level rise, the elevation of Nalsarovar came to within few meters of its present elevation at about 7 ka when it became a closed basin (Fig. 6). The mudflats, present to south of Nalsarovar, represent recent sea transgression in the area (GEER, 1998). Remnants of this sea are thought to be represented by the Nalsarovar.

As the Nalsarovar area is an old marine inlet and also receives water from its catchment, it can greatly influence the physical and the chemical properties of soil and water. On the basis of soil characteristics, they divided the area into three lithounits from the core obtained. Horizon-3 (18–45 m) clay and silt and silt clay with occasional sand lenses and basalt fragment base not reached. Horizon-2 (18–3 m) clayey silt with organic matter and shells of isttium and land snails. The presence of reed beds (10–14 m) is indicative of sub-aering exposure, presence of gypsum at 4 m – 7 m depth also indicate a period of an arid phase.

Nalsarovar is a natural shallow lake having maximum depth of about 1.5-2.0 meters when flooded. Maximum water depth at certain places is upto 180 cm during good rain year. The catchment area of Nalsarovar is 3082.5 sq km. Area under submergence in and around the sanctuary during good rain year is about 350 sq. km. Average total area of the sanctuary under submergence in winter is about 60 sq. km during normal rainfall. Thus the actual water body is less than the actual notified area of the sanctuary under the wildlife (Protection) Act, 1972. Submergence areas of the sanctuary at different water depth classes are given (GEER, 1998) as under in Table 5.

Table 5. Submergence areas of the Nalsarovar at different water depth

Water level in the lake RL (m) in meter	Area under Submergence (ha) in different water depth classes					
	Water depth classes (cm)					Total Submergence for different RL
	0-20	20-40	40-60	60-80	80-100	
8.20	41	–	–	–	–	41
8.40	453	41	–	–	–	494
8.60	802	453	41	–	–	1296
8.80	1179	802	453	41	–	2475
9.00	1500	1179	802	453	41	4100-4400

Level of the deepest point of lake is about 8.2 RL and water starts flowing out when water level exceeds 9.5 RL. Area of submergence under water at this level would be about 50 sq. km. Area under water-spread remains high during good monsoon as water continues to flow out till October and November depending on duration of monsoon. pH value of the water in lake recorded from 7.0 to 7.5 in beginning of winter to 8.0 to 9.5 in summer when water is reduced to small areas.

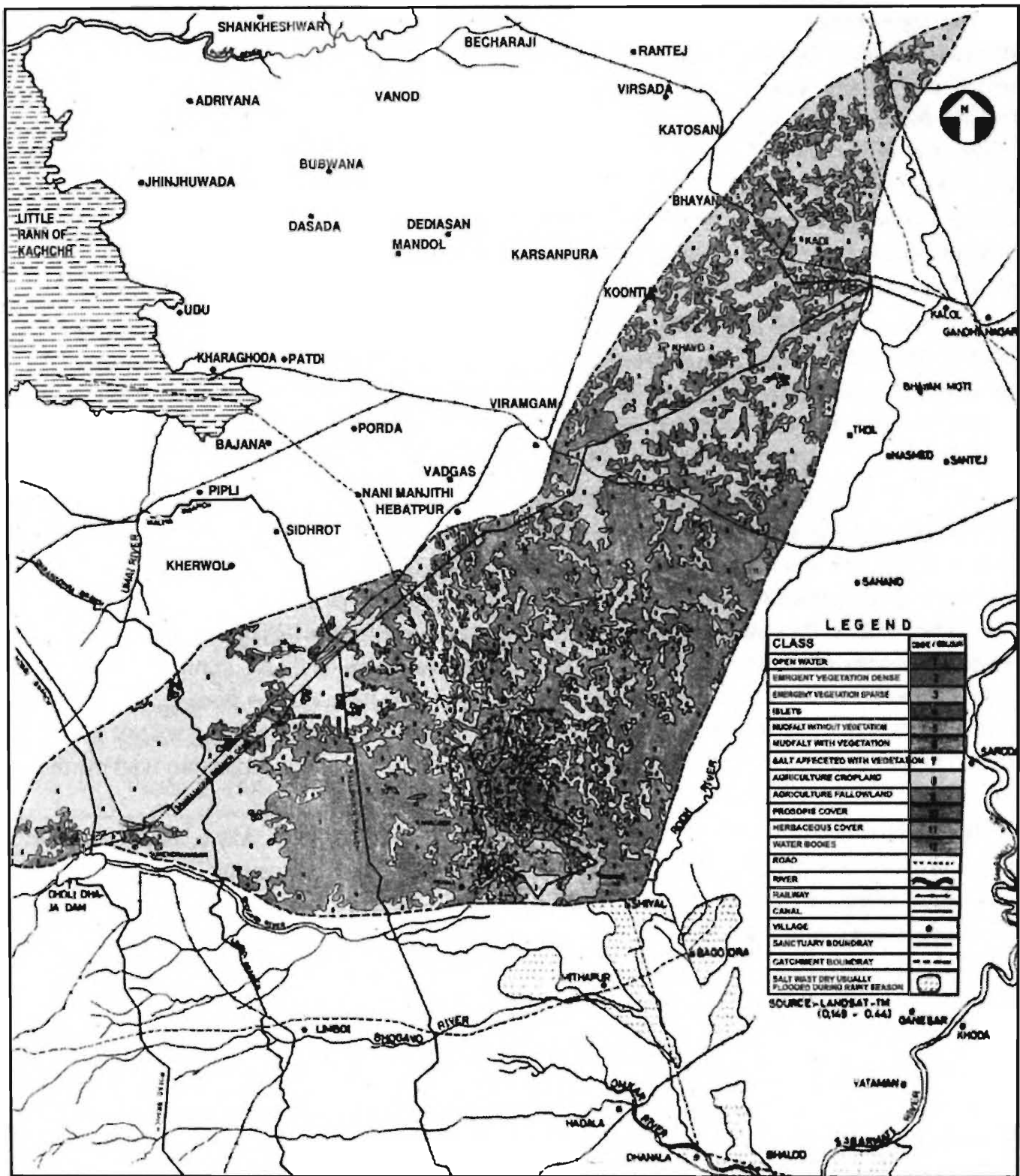
The area receives water mainly from two rivers viz. the Brahamni and the Vadhavan-Bhogavo. It also receives water from the surrounding catchments in north, west and east which are having gentle slopes. There appears gentle drainage from north-west to south. During the monsoon water is also received from Fatehwadi canal. The lake gets filled with water that drains from adjoining Surendranagar and Ahmedabad districts in the monsoon. With this fresh water inflow, brackishness in the lake is reduced considerably. The water quality parameters change from time to time and season to season. During monsoon the lake contains fresh water, which gradually becomes salty and at last completely saline due to mixed up waters of the rivers from Gulf of Khambhat (Fig. 7).

The Saurashtra Branch Canal passes through Kadi, Viramgam, Lakhtar and Wadhwan talukas. The different structures from this canal are proposed to facilitate the best running of the canal. The structure called an 'escape' is proposed at Ch. 57.780 km for taking care of mismatching of the flow, sudden failure of pumps, electropower supply etc., on Saurashtra Branch Canal.

Canal is passing through the Bhaskarpura tank area in Lakhtar taluka. The locations of the escape is proposed just upstream of Bhaskarpura tank. The capacity of the escape is designed for full capacity of Saurashtra Branch Canal, i.e. for 319 cumecs. (i.e. 11000 cusecs). It is proposed to release the escape water of Saurashtra Branch Canal in Bhaskarpura tank. The tank is shallow with very little depth of water, hardly 50 to 75 cm. It has broad crested spillway of 30 m length having discharging capacity of 31.82 cumecs. The surplus water from the tank is passing through existing spillway towards the Nalsarovar direction, ultimately which ends into the Gulf of Cambay. During heavy rains, water does not drain out immediately as the terrain of this region is very flat and hence some times, the water remains for long period in the area.

The state highway number 17 (S. H. 17) from Surendranagar to Ahmedabad passes d/s (drain section) at a distance of approximately 150 m from the spillway of Bhaskarpura tank. The water released through spillway of Bhaskarpura tank passes through this bridge and ultimately meets Nalsarovar through the natural drain.

This drain is said to be as low lying area ranging from 5 to 7 km width in general, with approximately 1 : 5000 slope towards Nalsarovar. During very good monsoon, this area gets flooded with 2 to 2.5 m deep water, which slowly drains out in Nalsarovar. The total length of drain from Bhaskarpura tank to Nalsarovar is about 17 km. Looking to the topography of the area, the initial 10 km length from Bhaskarpura tank upto Moti Kathechi village to Nalsarovar i.e. Near Nani Kathechi, is 5 km which has practically less capacity in comparison to discharge of SBC of 319 cumecs. Some modifications are required for this portion of drain. When full capacity, escapes starts discharging 319 cumecs of water it may be required approximately 5 hours to fill the Bhaskarpura tank. Then after the initial drain portion i.e. from Bhaskarpura to Moti Kathechi has the depression where temporary storage of escape water is possible which requires approximately 17 hours to fill i.e. about one day. Therefore, especially in dry season, this temporary storage very much reduces the severeness of the discharge at the far end.



SOURCE : GEER 1998

Fig. 7 : Land Cover / Land Use Classes in Catchment Area of Nalsarovar Wetland, Gujarat

There are two main spillways on Shiyal to Kalivaji road to dispose off the excess water of Nalsarovar when water level of Nalsarovar Lake is above the spillway level. At that time, if discharge from escape of SBC may come, the existing spillway capacity is required more, to pass additional 319 cumecs. It is required to provided 1 km long spillway cum causeway with 0.9 m spillway depth, which is sufficient to pass 319 cumecs discharge.

The lake and the catchments area falls in the arid to semi-arid tract. It is found that during the drought years, the water is not retained in the lake throughout the year. It is documented by GEER (1998) that in past years Nalsarovar had dried completely. Even during present study period, the lake was found completely dried during year 2003. Thus the water level of the lake is dependant on rainfall in the catchments area and area under the submergence varies every year. SSP authorities have shown possibilities of joining Ghoda feeder channel with the Narsingpura branch canal and supplying water to Nalsarovar as and when required, if the management is certain about its beneficial impacts (Alagh *et al.*, 1995). The area also falling under the region-6 of the SSP command was considered to be used as a reservoir, which was felt counter productive in due course. Hence, the idea of using Nal as a storage tank had been dropped. This decision has been felt justified as otherwise it was bound to bring drastic changes in the ecosystem of the lake, adversely affecting its habitat conditions GEER (1998).

After monsoon the process of drying up begins and water remains in about one third of the lake area in winter, during the normal rainfall year. In the years of less rainfall it dries up completely. While during the years of severe drought the lake area remains dry even during the winter. The population of waterfowl in the lake area depends upon the water level of the lake. Thus, the entire lake ecosystem is rainfall dependent.

Presently, Ghoda feeder canal of Fatehwadi irrigation project drains into the lake, through which excess water drains into the area. However, the quantity of water is so limited at present that there is hardly any sizeable quantity of water been poured in the lake so far. This is also because of requirement of water within the command area of Fatehwadi Canal. The lake ecosystem is considered as lentic ecosystem as its water remains stagnant for most part of the year, except in the period when it overflows (Fig. 8).

2.6 Soil

Mostly soil show a greater proportion of sand than silt and clay as most of the bets are flooded by water from upstream, which bring sand along with water and hence sand fraction is high. However, analysis of soil texture of the bottom sediment (i.e. when water recedes, lake dries up) has shown that the soil exhibits a typical lacustrine feature, i.e. silty-clayey. This is evident on drying soils, from land showing black patches and charred masses. This clayey part or fraction of Nal region makes its soil and land highly waterlogged. Soils in the upper strata of study area have greater proportion of sand relative to silt and clay. Hence water holding capacity and soil moisture content are lower.

However, despite of more proportion of sand in the upper strata of the lakebed, there is relatively less percolation or seepage, due to high proportion of clay and slit below it and due to higher water table, which makes area capable to retain water within it.

Normally the bulk density ranges from 1.1. to 1.5 g/cm³ for medium to fine textured soil and from 1.2 to 1.65 g/cm³ for the coarse textured soil. Soil samples with more of organic matter have relatively less density. The alkaline soils have a slight higher bulk density. The bulk density is inversely related to pore space of soil. The soils with high bulk density are inhibitive to root penetration, low permeability and infiltration. White salt crusts were also observed on soil dried up or drying throughout the Nal Kantha region. The halomorphic soil is typical of Bhal region, indicating soil spread over a 1/1/2 sq. km. between Shiyal and Sanknera, southern part of the lake. Suaeda, which is a typical halophyte i.e. saline plant, was observed in the vicinity of this patch.

2.7 Habitat

In an aquatic ecosystem the temporal behaviour of structural components of the wetland is the key to understand the type of habitat available and land use of the area. Nalsarovar is a known paradise of high diversity and population of birds, it can be inferred that the wetland encompasses almost all and varied habitat diversity suitable for harbouring mega assemblage of avifauna from waders to diving ducks including wetland dependant birds along with other faunal diversity components. The total area of the Nalsarovar under submergence during good monsoon reaches upto 350 sq. km. However, only one-third notified area of the sanctuary remain available for most waterfowls. The habitat suitability and habitat types remain ever-changing with respect to rainfall and withdrawal of water for irrigation by farmers.

With the help of satellite imageries, identification of certain habitat types, their distribution and monitoring changes in Nalsarovar was made with respect to only two avian species by Tatu (1995). At Nalsarovar habitat formations is highly dynamic, to the extent that habitats get changed from one type to another even within the same year due to change in the water level. Types of habitat in the sanctuary are: open water, emergent vegetation, islets (360), mudflats, uplands and *Prosopis* shrub lands. However on the basis of water level and vegetation eight habitat types (GEER, 1998) have been identified as (i) deep open water habitat above 60 cm depth without any emergent vegetation; (ii) shallow open water habitat (upto 60 cm) without any significant emergent aquatic vegetation; (iii) emergent aquatic vegetation where depth of water is variable but the surface of water is apparently not visible due to the dense growth of emergent aquatic vegetation; (iv) muddy habitat in shallow zone with receding water. The soil remains wet and muddy with sparse emergent vegetation; (v) Shoreland and island are the peripheral lake areas as well as bets which remain exposed with grasses, herbs and sparse scrubs; (vi) Cultivated areas including the agriculture land around the lake; (vii) Fallow lands including areas with large patches of fallow and wasteland surrounding the sanctuary and (viii) Woodland habitat on bets and on periphery of the lake (Plate 1 & 2).

3. REVIEW OF LITERATURE

Review of literature reveals that work on various aspects of Nalsarovar has been documented by IUCN (in prep); Koning and Koning-Raat (1975); De Block (1981); Gole (1984a, 1984b);

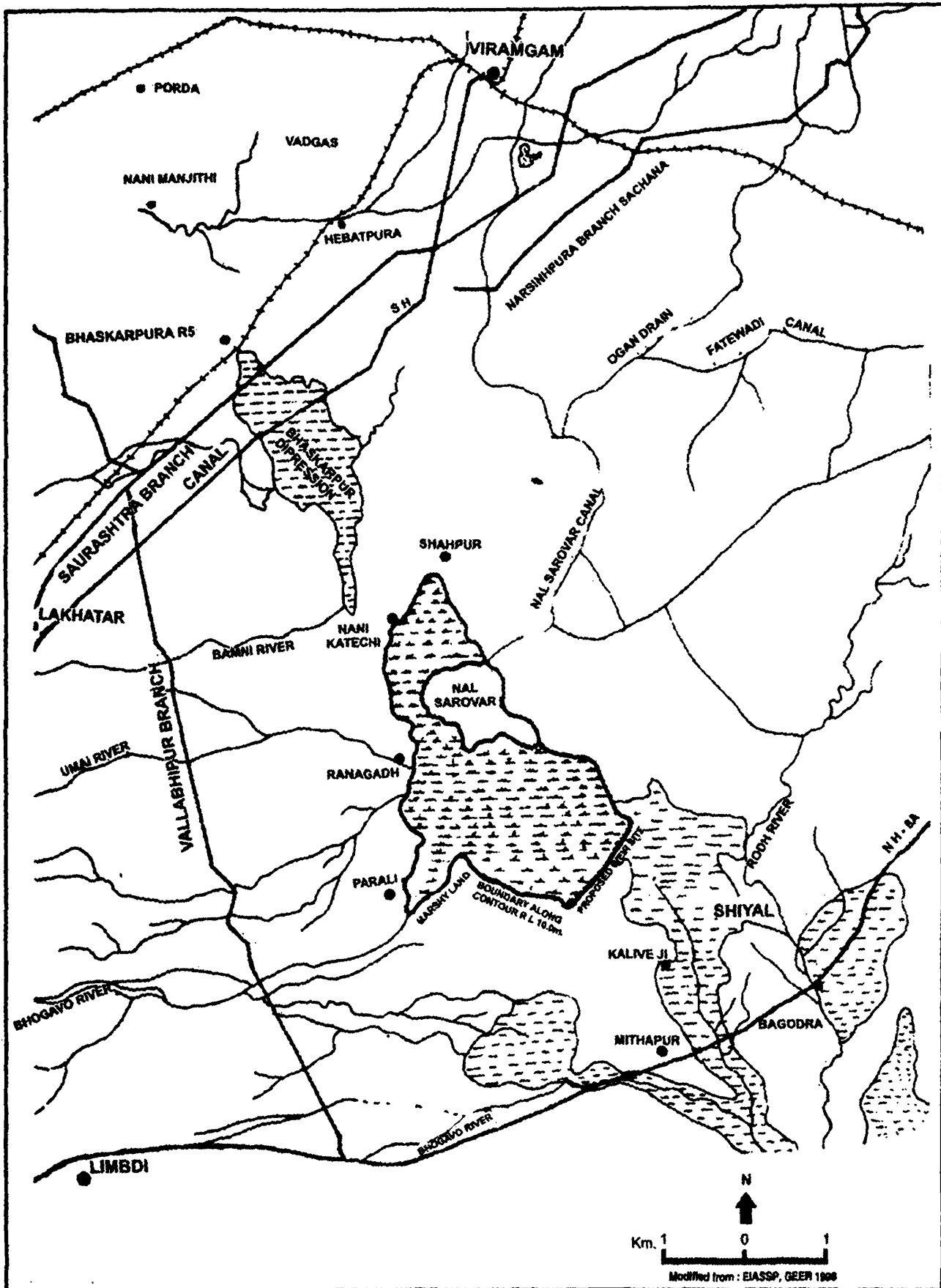


Fig. 8 : Map showing Canal network and proposed escape site.

Prasad and Thakur (1984), Daniel (1985); Karpowicz (1985); Khacher *et al.* (1987); WWF India (1987); Suthar *et al.* (1991); Prasad *et al.* (1997); Garg *et al.* (1998); GEER (1998); Anon. (1990-2000); Tatu (1995); Singh (1998, 2001); Java (1991); Parasharya, *et al.* (1999); Dutta (2000); ZSI (2000, 2004); Bhartiya (2002); Garg (2002 a&b); Islam and Rahamani, (2004) and Prasad (2004).

4. LIMNOLOGY

Water has the main role to play in an wetland ecosystem and being the universal solvent due to polar nature of its molecules, it attracts other charged molecules or ions and therefore plays a significant role in not only absorbing great amount of ionic material but also stabilizes atmospheric temperature due to its high specific heat. In a wetland ecotone, several unique properties of water creates a hydrological cycle resulting not only in formation of clouds but also its vaporization property keeps the temperature of adjoining land area low thereby creating a moist environment for perpetuation of life more prolific and unique. The science of wetlands popularly called limnology involves, besides water, physics, chemistry, considerable study of biota and almost all those entities and communities of earth's environment around it.

Wetlands or lakes are formed when the clouds precipitation moves on land and drains through streams and rivers and gets accumulated in earth's natural and manmade depressions. They are highly dynamic systems, which continuously interact with other systems and anthropogenic activities in their catchment's in various ways. All ecosystems interact with adjoining ecosystems in some manner that are more varied and intense in case of natural wetlands like Nalsarovar. It is also a fact that wetlands are relatively more fragile ecosystems because the wetland biota is adapted to rather narrow hydrological regime. Hydrology in this case refers to all water related features such as precipitation, inflow and outflow, evaporation and the resultant factors like the depth and duration of water, frequency and duration of flooding, and the amplitude of water level changes. Therefore, even small changes in the hydrological characteristics of the lake after completion of Narmada canal would bring about significant changes in the community structure and function. In view of this fact, the management requires a good understanding of wetlands ecology, their functions and values.

Gujarat has a few unique wetlands, whose water quality varies from fresh to brackish or saline, either under the influence of inherent salinity of the soil of the basin coupled with rapid evaporation or under the influence of the tides of the sea or both. Nalsarovar, Khijadiya Sanctuary, Little Rann of Kachchh and the Great Rann of Kachchh are some of the important freshwater wetlands of Gujarat. All of these wetlands are marvellous water-bird habitats but Nalsarovar is unique among all the wetlands due to its reed beds and bets. Though abundant knowledge on limnology of Indian waters in general is available, the freshwater wetlands of Gujarat in particular are almost untouched. Only scattered study reports are available on the regional wetlands of which mention can be made of the work on fresh water reservoirs of Gujarat mainly dealt by Das (2004) who documented Protozoa and McClure, *et al.* (1978)

who has reported mostly parasitic protozoa from Gujarat. Limnology including zooplankton diversity and their seasonal variations from Nalsarovar wetland have been studied by GEER (1998) and Singh (2001). The present study was undertaken to record various physicochemical parameters of Nalsarovar wetland.

Description of Study Area

The Nalsarovar is located between (Lat. 22°78' N Long. to 22°96' N and Long 71°92' E to 72°64' E). The area is located amidst the semi-arid lands of Ahmedabad and Surendranagar districts, about 65 km away from Ahmedabad (Fig. 1). It is one of the largest shallow freshwater lakes in India. It has been proposed a Ramsar site and declared an important IBA site: Site Code : IN-GJ-09. The lake has an elliptical basin with gentle slope. The shore line of the lake is barren and is surrounded by dry land and some crop fields (Singh, 2001).

Nalsarovar is unique by virtue of its reed beds. It is a natural shallow depression, which is an old marine inlet, silted up in recent times between the head of the Gulf of Cambay and the Rann of Kachchh. The lake receives water mainly through two rivers the Bhogavo and the Brahamni, which drain into the lake. The catchment run-off is dependent upon monsoon rainfall, which is normally 650 mm. A small quantity is also received through the surrounding catchments area. The lake ecosystem is considered as lentic ecosystem as its water remains stagnant for most part of the year, except the period when the lake waters overflow. Morphometric features of the lake are given in Table 6.

Table 6. General Morphometric features of the Nalsarovar.

Parameters	Values
Shape	Elliptical
Surface area (Sq. Kms.)	12,082 ha
Altitude	10-15 m
Max. depth (m.)	2-3 m
Average depth (m.)	1.8 m

The lake dries out completely in years of low rainfall. It was reported to dry in 1986. The lake after 16 years dried up again in 2003. During very heavy monsoons, the water may be as much as two-three metres deep. There are 360 islands, 36 of which are fairly large scattered in the lake. Most of these islands remain submerged during the monsoon and are exposed when the water level recedes. Salinities range from fresh in winter to slightly brackish in summer.

MATERIAL AND METHODS

The lake was surveyed from 1999 to 2003 all across its length and breadth. In all 50 odd samples of lake water from sub-surface and bottom were collected from 10 sampling stations from all possible water zones. The area near Vekaria village was avoided due to human

activity such as bathing etc. The samples of lake waters were made twice a year for one week to evaluate hydrographic, limnochemical and limnobiological parameters.

For quantitative estimation of zooplankton, 10 litres of surface water was filtered through plankton net made of bolting silk No. 25. The column and bottom water samples were collected by using St. John's water sampler (Kumar, 1992) and filtered through the same net.

Quantitative study of phytoplanktons was done by filtering 10 litres of lake water through small plankton net. The column and bottom water samples were collected by using St. John's water sampler (Kumar, 1992) and filtered through the same net. Haemocytometer was used to estimate the phytoplankton numbers and counting was done by Sedgwick rafter slide under CZ inverted microscope. The density was expressed as phytoplankton cells per ml. of the sample.

Standard methodology was followed for field collection and analysis work. The physico-chemical measurements for different parameters were made *in situ* by a high precision digital RQflex instrument using Rflectoquant system. The data gathered was then pooled and compared to get an average value parameter-wise (Table 7). The whole gamut of physico-chemical parameters have been recorded, the inferences are summarily restricted to a few representative values indicating the physicochemical and trophic status of the lake water as the whole exercise was restricted to a few survey attempts and not the seasonal observation.

Table 7. Physicochemical parameters recorded during the year 1999-2003 from Nalsarovar Wetland, Gujarat

Parameters	3rd week of January 1999	4th week of March 1999	3rd week of February 2000	2nd week of December 2000	2nd week of October 2001
Air temperature °C	20.0	27.4	21.0	23.0	25.0
Water temperature °C	25.3	26.8	25.0	20.6	24.0
pH	7.9	7.0	7.6	8.4	7.8
Depth of visibility, cm.	52	30	48	45	35
Dissolved O ₂ mg/l.	3.8	2.6	3.5	2.8	3.1
Free CO ₂ , mg/l.	18.2	12.4	18.5	20.5	23.4
Carbonates, mg/l.	2.4	3.7	5.3	3.1	2.9
Bicarbonates, mg/l.	230.0	134.1	100.0	98.2	156.8
Calcium, mg/l.	42.7	20.7	9.5	95.6	35.8
Magnesium, mg/l.	20.2	46.7	67.8	82.4	26.7
Chlorides, ppm.	754.0	19.8	18.5	20.6	22.4
E. C., μ mhos/cm.	725	3640	7500	8450	3125

RESULTS AND DISCUSSION

Temperature

Data collected on temperature shows that distinct thermal stratification does not take place in Nalsarovar. The average variation between the atmospheric temperature and that of water was found to be 1° to 4°C. The variation in the temperature regimes of water at the surface and below the surface was negligible, which might be due to the shallowness of the lake and the stagnant water.

Vijayan (1991) had recorded similar observations at the wetland of Keoladeo National Park (Bharatpur) and observed that temperature of water and air runs closely during the winters.

pH (Hydrogen ion concentration)

pH value measured at various sampling sites shows that initially when rain water drains into the area its pH value is between 7.0 and 8.4 indicating almost neutral character to fluctuating between acidic and alkalinity of lake waters. It is likely that the rainwater during run-off might be draining some amount of salts from the surface, which are alkaline in nature, due to which the water shows slightly alkaline pH, i.e: 7.6. Moreover, in the beginning of the rainy season, the lake water is more alkaline, which after getting mixed with the fresh water gets diluted and the lake water shows slight alkalinity.

Chlorides

Values obtained for chlorides (Table 7) in the lake water show typical conditions prevailing in the area due to its geological structure. Chlorides content has been found increasing from post-monsoon through winter to summer, being lowest in the post-monsoon and highest in summer. The reason for this can be attributed to the soil at the bottom and climatic conditions prevailing in the area. Chlorides being water soluble, leach down on accumulation of rain water in the lake and hence the low values during the monsoon and the post-monsoon period. Once the monsoon is over, and inflow of water is ceased, there is a gradual shrinkage of the waterbody due to the evaporation, which accelerates with the rise in the temperature. As a result, chloride concentration increases. On the other hand chlorides, mainly CaCl_2 and/or MgCl_2 come up and ooze out by the capillary action. Resultantly, chloride concentration reaches the peak during the summer.

The trend observed clearly indicates its impact on the vegetation. During winter of 1999, it was highest at Nal-Brahamni river junction, which was without any vegetation. When the lake area dries up fully salt encrustations on the upper surface of the soil are clearly visible.

It has also shown inherent salinity of the soil. Sen *et al.* (1982) had also observed similar phenomenon in the areas of western Rajasthan where chlorinity in water is inherent in nature. Vijayan (1991) had also observed rise in chlorinity during the summer at Bharatpur.

Dissolved Oxygen (DO)

DO was found generally within the normal range indicating that oxygen is not a limiting factor. Dissolved oxygen varied from 2.6 mg/l. to 3.8 mg/l. during the study period. However, at least one sample collected near Dhrabla bet had shown very low DO. As this is a bet area with a large number of algae growing along with sedges and reeds, it is likely that oxygen is consumed by these vegetation as well as gastropods, fishes, etc., to the extent that no sooner oxygen is evolved it is used by the living organisms. Low oxygen value also indicates its chemical use, as there are large number of salts, i.e. carbonates and bicarbonates.

Alkalinity

Alkalinity is measured by carbonates (CO_3^-) and bicarbonates (HCO_3^-) present in the water. The trend observed is quite similar to that in the case of chlorides and hardness. During monsoon, when there was fresh inflow of water, alkalinity was low, which gradually increased in winter and reached to highest during the summer.

However, when the results are compared with respect to various places, it seems that it varies with places and also varies with the drying process. It is evident from the results observed (Table 7) that alkalinity from post-monsoon period onwards, is almost highest at Brahmni river which is the main source of water for the lake. At this site, drying process is also faster due to its higher elevation.

Hardness

Total hardness was also found highest in surface water near Brahmni bank followed by juncture of Brahmni River to the lake's surface, but again in the vegetated area it was less. Hardness is either due to Ca or Mg. Hardness increases with increase in temperature. Low hardness in winters may be due to high volume of water and vegetation. The CO_2 is utilized by plants and hence its amount reduces. Calcium and Magnesium being absorbed by living organisms, hardness is low when vegetation decomposes, they are released back into the substratum, increasing hardness thereby. Both Ca and Mg show variable concentrations from place to place and from season to season (Table 7). Palmer (1967) and Graham *et al.* (1974) have reported higher value of calcium in fertile water. Zafer (1964 a & b) considered Ca as an important factor which influenced the distribution of diatoms in water bodies.

Plankton and visibility of water

Nalsarovar waters were found to have high-density of phytoplankton. They were represented by seventeen species of Chlorophyceae, four species of Bacillariophyceae, two species of Euglenophyceae and 25 species of Cyanophyceae. The blue green algae were the highest followed by the greens and the diatoms, which were mostly recorded in more of stagnant zones. The zooplankton population was mainly represented by rotifers, cladocerans, copepods and many insect larval forms. The population abundance was very much fluctuating and found to be insignificant in case of Protozoa, Ostracoda and Decapoda whereas moderate to high population was recorded for rotifers, cladocerans and copepods.

The light penetration is grossly effected by two factors the dissolved organic / particulate matter and density of phytoplankton population. Though depth of visibility was found to be varying in different water zones of the lake but on an average assessment of visibility factor, it was found to be more during winter months as compared to summer. Bohra (1977) also reported an inverse relationship between total phytoplankton and depth of visibility during March-April. Phytoplankton affected depth of visibility only during March-April. In the months of monsoon, it was the dissolved organic and particulate matter that contributed to the visibility values. Water clarity of Rajasthan waters have also been worked out by Sharma and Durve (1991). The transparency of water can be directly related to the density of plankton where turbidity due to drainage of soil eroded water is not an important factor. Since the visibility value is approximately 5% of the penetration of solar radiation, it can serve as an index of primary productivity excluding rainy periods (Hutchinson, 1957).

5. FLORA

The Nalsarovar with its rich habitat diversity accordingly harbours number of floral and faunal elements. Ecological study of Nalsarovar (Gujarat) with an emphasis on its floristic and avifaunal profile using satellite remote technique have been studied by Tatu (1995). Structural components and land use patterns analysis in the catchment of Nalsarovar notified wetland as an aid for biodiversity conservation using remote sensing techniques was studied by Garg (2002 b). Forty-eight species of algae, 72 species of flowering plants have been recorded from the area (Singh, 2001).

The green carpet of aquatic vegetation formed by a variety of plant species such as *Vallisnaria*, *Ceratophyllum* and *Chara*. Algae not only exists under water surface, but also above it. Luxuriant cover of emergent vegetation of *Typha*, *Eleocharis* or sedges and aquatic grass exists on fringes and surrounding some islets or bets. The patches of such emergent vegetation amidst the water and along the shore create 'edge effect' to the benefit of the waterfowl. An eco-tourist can see the mosaic of micro-habitats with the sanctuary. The height of the emergent aquatic plants ranges from a foot to over 5-6 feet. The emergent cover provides food and shelter to certain secretive bird like bittern and other birds like glossy ibis, openbill stork, purple heron, moorhen, jacanas, reed warblers, swallows and wagtails.

The common aquatic plants are *Cyperus* sp., *Scirpus* sp., *Typha unguistata*, *Eleocharis palustris*, *Ruppia*, *Potamogeton*, *Vallisnaria*, *Ceratophyllum*, *Naias*, *Chara* and innumerable forms of algae. Forty-eight species of algae belongs to four groups: Cyanophyceae, Chlorophyceae, Bacillariophyceae and Euglenophyceae (Table 8).

Macrophytes, *i.e.* Pteridophytes and Angiosperms occurring in the area clearly indicates habitats and condition prevailing in the area of its occurrence (Singh, 2001). They indicate swampy, muddy, saline or sandy habitats and appear either seasonally or perennially. Eighty three species of flowering plants (Table 9) are recorded from Nalsarovar (GEER, 1998).

Bets in the Nal also have scanty to moderate vegetation. Near most of the bets, there appears reed-meadow sedge, where due to siltation, sedges, grasses and cattails grow abundantly. These include *Cyperus bulbosus* (Thek) and *C. rotundus* (Chiyo) which are taken as food by local people. These plants also play an important role of air circulation in the lake, as they are hollow and possess aerenchymous tissues. They help in gaseous exchanges of CO₂ and Oxygen, which are thus made available to the submerged species.

Mangrove *Avicinia* spp. (Cher) is found on Nana Chera and Mota Chera. On the bets main tree species are *Salvadora*, *Acacia nilotica*, *Tamaris* sp, *Zizyphus bushes* and *Prosopis juliflora*. Within the tourist complex at Vekaria *Azadirachta indica*, *Kigelia pinnatta* and *Parkinsonia accuminata* are found along with Eucalyptus trees which are extensively used by birds.

The main tree species in the vicinity of lake outside the sanctuary area being *Salvadora*, *Acacia nilotica*, *Azadirachta indica*, *Prosopis cineraria* and *Prosopis juliflora*.

Table 8. Aquatic Floral Diversity of Nalsarovar Wetland, Gujarat

CHLOROPHYCEAE (GREEN ALGAE)	Status
<i>Bulbochaete</i> sp.	Abundant
<i>Chara erythrogyna</i>	Abundant
<i>Chara globulans</i>	Abundant
<i>Eudorina</i> sp.	Few
<i>Eustrium elegance</i>	Abundant
<i>Cladophora cristata</i>	Abundant
<i>Cosmarium contractum</i>	Moderate
<i>Coleochaetae scutata</i>	Moderate
<i>Mougetia</i> sp.	Occasional
<i>Nitella accuminata</i>	Abundant
<i>Nitella transilis</i>	Abundant
<i>Oedogonium multisporum</i>	Moderate
<i>Oedogonium tyroticcum</i>	Moderate
<i>Spirogyra gratima</i>	Few
<i>Spirogyra pretensis</i>	Abundant
<i>Ulothrix contrata</i>	Moderate
<i>Ulothrix zonata</i>	Moderate
CYANOPHYCEAE (BLUE-GREEN ALGAE)	
<i>Anabaena sphaerica</i>	Moderate
<i>Aphanothece saxicola</i>	Moderate

Table 8. Contd.

<i>Aphanocapsa montena</i>	Moderate
<i>Aphanocapsa pulchra</i>	Abundant
<i>Aulosira prolifica</i>	Abundant
<i>Chroococcus macrococcus</i>	Abundant
<i>Chroococcus minor</i>	Abundant
<i>Gloeocapsa atrata</i>	Abundant
<i>Gloeocapsa</i> sp.	Abundant
<i>Johannesbaptista pellucida</i>	Moderate
<i>Lyngbya aeruginieo coerulea</i>	Abundant
<i>Lyngbya puteallis</i>	Abundant
<i>Merismopedia convoluta</i>	Moderate
<i>Microcoleus subtorulosus</i>	Moderate
<i>Microcystis flosaque</i>	Abundant
<i>Nodularia</i> sp.	Moderate
<i>Oscillatoria obscura</i>	Abundant
<i>Oscillatoria princes</i>	Abundant
<i>Oscillatoria subbrevis</i>	Abundant
<i>Phormidium bohneri</i>	Moderate
<i>Rivularia</i> sp.	Abundant
<i>Scytonema coactile</i>	Abundant
<i>Scytonema jaganicum</i>	Abundant
<i>Spirulina subilissima</i>	Moderate
<i>Tolypothrix</i> sp.	Moderate
BACILLARIOPHYCEAE (DIATOMS)	
<i>Zygnema</i> sp.	Abundant
<i>Cymbella</i> sp.	Abundant
<i>Fragillaria</i> sp.	Abundant
<i>Navicula</i> sp.	Occasional
EUGLENOPHYCEAE	
<i>Euglena</i> sp.	Abundant
<i>Phacus</i> sp.	Abundant

Source : GEER (1998)

Table 9. Vegetation in and around Nalsarovar wetland, Gujarat.

Family	Plant Species	Local name	Status
HERBS			
Marsileaceae	<i>Marsilea quadrifolia</i>	–	Aquatic
Capparidaceae	<i>Cleome viscosa</i>	Pilitilvan, Pili tanvani	Bets, Sandy soil
	Temaricaceae	<i>Tamarix dioica</i> Bhuripras	Achhil, Aigoparas, Bets
Elatinaceae	<i>Bergia odorata</i>	Jaljambo, Gandharo, Okhrad	Dried mud flats
Tiliaceae	<i>Corchorus olitorius</i>	Borchhuchh	Bets, Dry area
	<i>Corchorus aestuans</i>	Chunch, Chhadhari	Bets, Dry area
Zygophyllaceae	<i>Tribulus terrestris</i>	Bethu Gokhru, Mithu Gokhru	Bets, Dry mud-flat, Sandy area
Papilionaceae	<i>Alysicarpus rugosus</i>	–	Bet, Shoreland
	<i>Alhagi pseudalhagi</i>	–	Sandy areas
	<i>Aeschynomene indica</i>	–	Moist place
	<i>Crotalaria medicaginea</i>	Abdaumethi, Ranmethi	Bets, Shoreland
	<i>Indigofera enneaphylla</i>	Fatakiya, Bhonygal	Common
	<i>Sesbania sesban</i>	Sevri, Jayanti	Common
Lytheraceae	<i>Ammannia baccifera</i>	Aganbuti	Damp place
Onagraceae	<i>Ludwigia perennis</i>	–	Common
Aizoaceae	<i>Trianthema portulaca</i>	Satodo	Shoreland
Compositeae	<i>Caesulia axilloies</i>	–	Damp places
	<i>Eclipta alba</i>	Bhangro	Damp places
	<i>Vernonia cineraria</i>	Sahadevi, Sadedi	Shoreland
	<i>Xanthium strumarium</i>	Gokhru, Gadariya	Common
Gentianaceae	<i>Enicostema littorale</i>	Mamejevo	Bets, Shoreland
Boraginaceae	<i>Heliotropium indicum</i>	Hathi sundha, Hathi sundho	Mud-flata, Damp areas
	<i>Heliotropium ovelegheia</i>	–	Mud-flats, Damp areas
Convolvulaceae	<i>Evolvulus alsinoides</i>	Kali shankha vali, Zini Fudardi	Common
	<i>Cressa critica</i>	–	Common
Convolvulaceae	<i>Convolvulus</i> sp.	Shankpusphi	Common

Table 9. Contd.

Family	Plant Species	Local name	Status
Solanaceae	<i>Physalis purpurea</i>	–	Along with grass
	<i>Solanum xanthocarpum</i>	Bhoringni	Common
	<i>Solanum nigrum</i>	Piludi	Common
Scrophulariaceae	<i>Bacopa monnieri</i>	Bam, Jalnaveri	Moist Grass
	<i>Peplidium martimum</i>		Salt affected area
Pedaliaceae	<i>Pedaliium murex</i>	Ubhu Gokharu, Motu Gokharu	Sandy coast
Acanthaceae	<i>Justicia procumbens</i>	Pitpapdo	Moist Sandy area
Verbinaceae	<i>Phyla nodiflora</i>	Ratvello, Ratalio	Common
Nyctaginaceae	<i>Boerhavia rependa</i>	–	Common
	<i>Boerhavia diffusa</i>	Satodi	Common
	<i>Achyranthes aspera</i>	Andhedo, Anghedi	Common
Amaranthaceae	<i>Celosia argentia</i>	Lambdi, Lampdi	Common
Chenopodiaceae	<i>Suaeda maritimum</i>	Luno, Lano	Saline area
Polygonaceae	<i>Polygonum plebeium</i>	Ratanjoth, Zincookharrrd	Moist place
Caryophyllaceae	<i>Polycarpia corymbosa</i>	–	Sandy area
Euphorbiaceae	<i>Euphorbia hirta</i>	Durnell	Common
Commelinaceae	<i>Commelina benghalensis</i>	–	Common
	<i>Commelina nodiflora</i>	Shishmuli	Moist ground
Typhaceae	<i>Typha angustata</i>	Ramban, Ghabanjaria, Janglibain	Moist, Marshy land
Cyperaceae	<i>Cyperus alterneplia</i>	–	Moist areas
	<i>Cyperus arenarius</i>	–	Sandy ground
	<i>Cyperus bulbosus</i>	–	Common
	<i>Cyperus compressus</i>	–	Sandy loam soil
	<i>Cyperus difformis</i>	–	Common
	<i>Cyperus esculentus</i>	–	Common
	<i>Cyperus elauanoides</i>	–	Common
	<i>Cyperus exalta</i>	–	–
	<i>Cyperus haspan</i>	–	Amid grasses
	<i>Cyperus niveus</i>	–	–
	<i>Cyperus pangonri</i>	–	Dampy areas

Table 9. Contd.

Family	Plant Species	Local name	Status
	<i>Cyperus rotundus</i>	Moth chidho	Common, moist areas
	<i>Cyperus triceps</i>	–	Moist areas
	<i>Eleocharis dulcis</i>	–	Submerged water-logged soil
	<i>Fimbristylis dicotoma</i>	–	Common
	<i>Scirpus maritimus</i>	–	Common
	<i>Scirpus grossus</i>	–	Common
	<i>Scirpus littorelis</i>	–	Common
Poaceae	<i>Aleuropus logopoides</i>	–	Sea coast common
	<i>Apluda mutica</i>	–	Common
	<i>Bothriochloa</i> sp.	Dharjo	Common
	<i>Cenchrus</i> sp.	Motu Dharmnu	Common
	<i>Dichanthium</i> sp.	–	Common
	<i>Saccharum</i> sp.	Sarkhant, Hadoi, Munj	Dry Sandy Soil
	<i>Setaria</i> sp.	–	Common
	<i>Spolobolus</i> sp.	–	Common
	<i>Vetiveria zizanioides</i>	Valo, Khus	Common
TREES			
Leguminosae	<i>Acacia nilotica</i>	Desi Babool	Bets
Mimoseae	<i>Prosopis juliflora</i>	Gando Baval	Bets
	<i>Prosopis cineraria</i>	Khijdo	Bets
Caesalpinieae	<i>Cassia fistula</i>	Amaltash	Bets
	<i>Parkinsonia accuminata</i>	Rambaval	Surrounding Area
Salvadoraceae	<i>Salvadora persica</i>	Piloo	Bets
	<i>Salvadora oleoides</i>	Jaal	Bets
Urticaceae	<i>Ficus</i> sp.	Bargad, Peepal etc.	Bets
Meliaceae	<i>Azadirachta indica</i>	Neem	Forest Guest House Area
	<i>Zizyphus</i> sp.	Ber	Bets and Surrounding Area
Bignoniaceae	<i>Kigelia pinnata</i>	–	Surrounding Area

Source : GEER (1998)

6. FAUNA

Gujarat, being distinct in its biogeographical characteristics harbours rich faunal diversity represented by number of invertebrates and vertebrates both aquatic (freshwater and marine) and terrestrial. Fauna of Gujarat has been mainly documented by GEC (1996), ZSI (2000 and 2004) and Singh (2001).

Among most wetlands of Gujarat, Nal sarovar is an important wintering habitat for thousands of birds coming from Siberia, Central Asia and Europe, resident as well as migratory. About 250 species of birds including 158 species of waterfowl have been recorded in the lake comprising of migratory and endangered species. Waterfowl population counted during January, 1996 was 1,41,540 belonging to 82 species. Some 20 species of fish were also recorded in the lake (GEER, 1998).

In addition to avifauna, the sanctuary also supports good population of reptiles, mammals and other wetland biota. During summer a breeding group of wild ass was seen in and around the sanctuary. Mongoose, wolf, hyena, jackal, fox, jungle cat are commonly observed and recorded from the very vicinity of the wetland.

In Nal sarovar, provisioning of habitat and food to a variety of animals (vertebrates/invertebrates) and plants (submerged and emergent) is one of the most important functions played by this wetland. Among plants, wetlands are especially essential for the existence of hydrophytes and among the animals they are especially important for fish, amphibians, aquatic reptiles/mammals and waterfowls (water birds). At Nalsarovar these forms a complex food web and provides food and shelter to a variety of birds and other aquatic organisms. Waterfowl represent the most conspicuous form of nal wetland fauna. Fish, frogs, aquatic insects and reptiles, algae and aquatic plants constitute main food of the birds. Their distribution and abundance depend on water level of the lake.

When the Nal is having enough water, an eco-tourist visits the area to see coots and variety of ducks like shoveller, pintail, common teal, garganey, wigeon, brahminy duck etc.; waders like Sandpipers, Godwit, Ruff, Plovers, Stints and some other magnificent waterfowl like Greater flamingo, Lesser flamingo, Spoonbill, Glossy ibis, White stork, Painted stork, Openbill stork, Caspian tern, Great black-backed gull, Demoiselle crane, Eurasian crane and Sarus crane. Besides these colourful migratory and resident birds, a variety of herons, egrets, rails, bitterns, moorhens, jacanas, sandpipers, stints, plovers, godwit, ibises, terns, gulls, wagtails and kingfishers can be seen at the wetland. Very little work is done on the faunal aspect of Nalsarovar. Most of the work is by GEER (1998), ZSI (2000, 2004) and Singh (1998, 2001).

Very little information is available on the invertebrate fauna of Nalsarovar. A mixed list of invertebrates comprising of 76 species of zooplankton and macro zooplankton including protozoa, to bugs, beetles, dipteran and hymenopteran larvae is documented by GEER (1998). Seven species of Odonata viz. *Pseudagrion decorum* (Rambur), *Ischnura senegalensis* (Rambur), *Rhodischnura nursei* (Morton), *Enallagma cyathigerum cyathigerum* Charpentier, *Agriocnemis pygmaea pygmaea* (Rambur), *Orthetrum sabina sabina* (Drury), *Crocothemis servilia servilia* (Drury) have been recorded by Prasad and Thakur (1984), Prasad (2004) from Nalsarovar as against forty-eight species recorded from Gujarat. Among vertebrates no

amphibian fauna was recorded from Nalsarovar. Twenty-two species of fish and ten reptilian species have been worked out by GEER Foundation (1998) and Singh (2001).

About 250 species of birds including 158 species of waterfowl have been documented so far by GEER (1998), Dutta (2000), Singh (2001) and Islam and Rahamani, (2004). Avifaunal profile using remote sensing has been studied by Tatu (1995), Parasharya, *et al.* (1999) who reported the presence of little gull from Nalsarovar, Gujarat. Nalsarovar has been popularized as a good place to photograph greater flamingoes Bhartiya (2002). According to GEER (1998) Nal alone supports as many numbers of birds as enumerated in other wetland sites of the state and even species wise Nal harbours more population of birds than others. Mammalian fauna associated with Nalsarovar wetland has been worked out by GEER Foundation (1998), Singh (2001) and Islam and Rahamani, (2004).

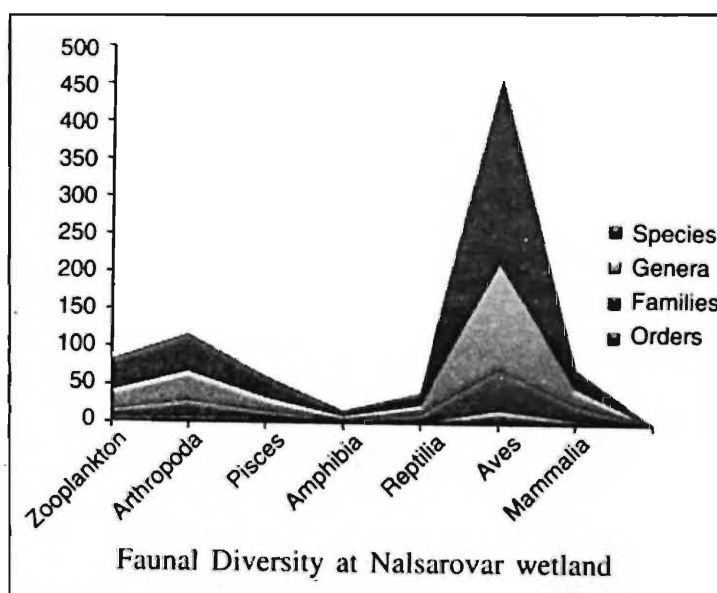
So far 76 species of zooplankton and zoo-benthos, about 250 species of birds including 158 species of waterfowl, 22 species of fishes, 10 species of reptiles and 15 species of mammals have been reported by earlier workers.

A vast diversity of invertebrates were collected from the lake and its surrounding habitat. Identification report of few groups such as aquatic Coleoptera, Odonata, Lepidoptera, Diptera, Crustacea and Mollusca etc. are still to be worked out. One species of scorpion *Mesobuthus tumulus gujaratensis* (Pocock) belonging

to family Buthidae of order Scorpionida was also collected from Dharabla Bet and a new record from Nalsarovar, Gujarat. At present 410 species of invertebrates and vertebrates are recorded from the lake (Table 10; Fig. 9. and 10). A number of groups collected are yet to be identified in the wake of unavailability of experts.

Table 10. Faunal Diversity at Nalsarovar Wetland, Gujarat.

Groups	Orders	Families	Genera	Species
Zooplankton	5	11	25	40
Insecta	5	21	38	47
Pisces	5	10	18	28
Amphibia	1	3	5	7
Reptilia	2	10	12	16
Aves	18	54	41	246
Mammalia	6	20	22	25



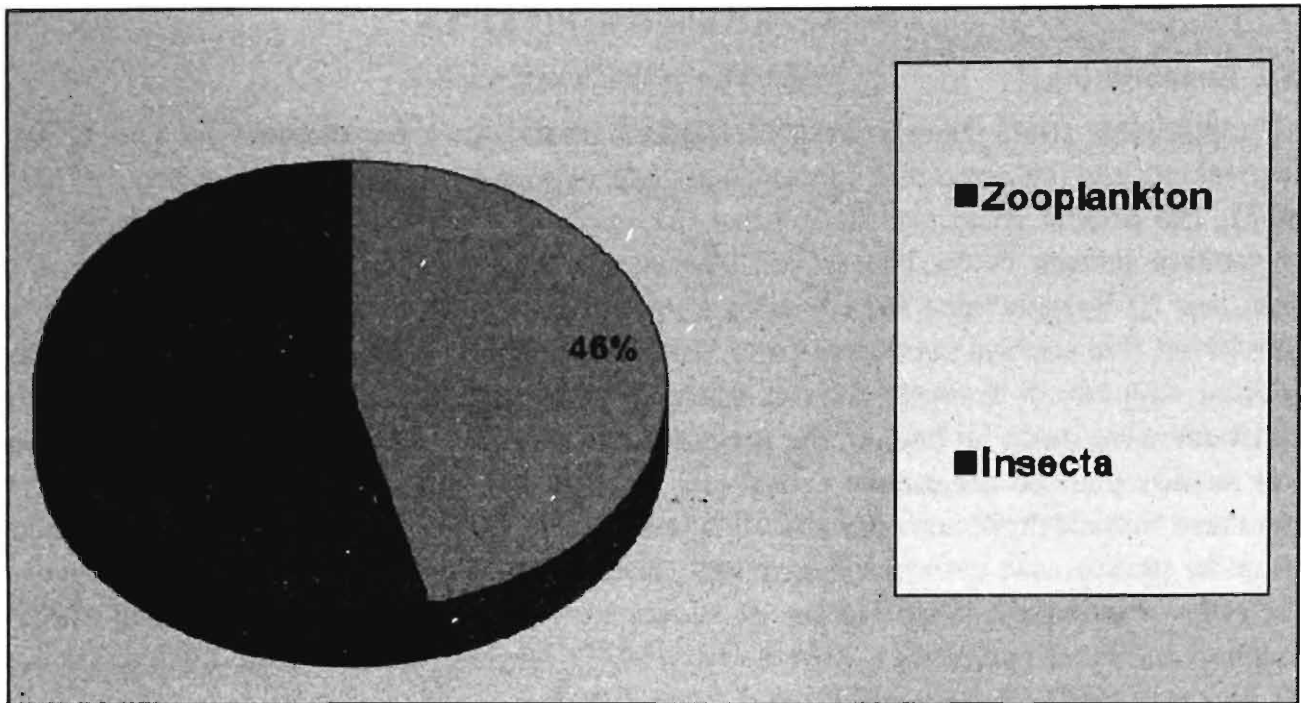


Fig. 9 : Invertebrate Faunal Diversity of Nalsarovar Wetland, Gujarat

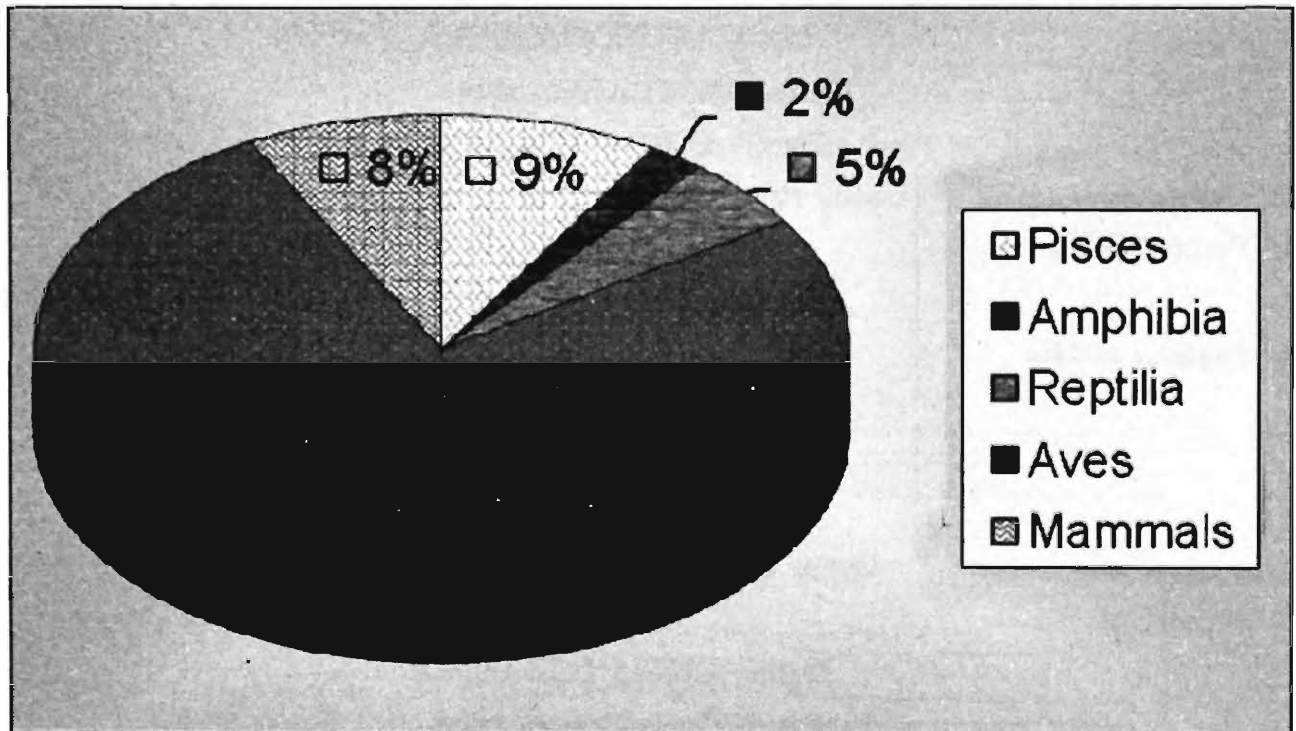


Fig. 10 : Vertebrate Faunal Diversity of Nalsarovar Wetland, Gujarat

6.1 INVERTEBRATE FAUNA

6.1.1 Zooplankton

Zooplankters from Gujarat are least studied. Protozoa is documented by Das (2004). Zooplankters and their seasonal variations of Nalsarovar wetland have been studied by GEER (1998). The present study was undertaken to record the species diversity and abundance of zooplankton present in the Nalsarovar. The zooplankton collections were made from four zones, viz. (i) Vekaria zone (ii) Dharabla zone (iii) Ranagadh zone and (iv) Brahmni river zone during five surveys conducted from September 1999 - August 2003. The samples were collected with 50 cm diameter ring net made up of bolting silk of mesh size 0.33 mm. The collections were made by hauling the net horizontally for few minutes at different collection spots already planned for sample collection. The collected samples were preserved in 4-5% neutralized formaldehyde and after processing enumerated by using Sedgewick's rafter counting cell under stereoscopic binocular microscope. Decapods and insect larval forms were counted separately. Taxonomic identification of zooplankton was made after Edmondson (1959), Needham and Needham (1962), Alfred, *et al.* (1973), Nayar (1965), Pennak, (1978), Michael and Sharma (1988), Sharma (1999) and Khan (2003).

Protozoans, Rotifers, Ostracods, Copepods, Cladocerans, Decapods and various larval forms of insects mainly constituted the zooplankton population of Nalsarovar waters.

SYSTEMATIC LIST OF FREE-LIVING ZOOPLANKTON HITHERTO RECORDED FROM THE NALSAROVAR WETLAND

PROTOZOA

Class MASTIGOPHORA

Order DINOFLAGELLIDA

Family PERIDINIIDAE

Genus *Peridinium* Ehrenberg 1838

1. *Peridinium* sp.

Genus *Euglena*

2. *Euglena viridis*

Class SARCODINA

Order TESTACEA

Family ARCELLIDAE

Genus *Arcella* Ehrenberg 1834

3. *Arcella* sp.

Family DIFFLUGIIDAE

Genus *Diffflugia* Leclerc 1838

4. *Diffflugia* sp.

ROTIFERA

Subclass EUROTATORIA

Superorder MONOGONONTA

Order FLOSCULARIACEAE

Family CONOCHILIDAE

Genus *Conochilus* Hlava 1908

5. *Conochilus* sp.

Order PLOIMIDA

Family BRACHIONIDAE

Subfamily BRACHIONINAE

Genus *Brachionus* Pallas 1907

6. *Brachionus angularis* Gosse

7. *Brachionus calyciflorus* Pallas

8. *Brachionus caudatus* Borrois and Daday

9. *Brachionus diversicornis* (Daday)

10. *Brachionus falcatus* Ahlstrom

11. *Brachionus rubens* Ehrenberg

Genus *Keratella* Bory de St. Vincent 1907

12. *Keratella tropica* (Apstein)

Family COLURELLIDAE

Subfamily COLURINAE

Genus *Lepadella* Bory de St. Vincent 1907

13. *Lepadella patella* (Müller)

Family LECANIDAE

Genus *Lecane* Nitzsch 1907

14. *Lecane (Luna) curvicornis* (Murray)

15. *Lecane (Luna) ludwegi* (Eckstein)

16. *Lecane (Luna) luna* (Müller)

17. *Lecane (Luna) nama* (Murray)

Genus *Monostyla* Ehrenberg 1834

18. *Monostyla bamata* Harring and Myers

Family ASPLANCHNIDAE

Genus *Asplanchna* Gosse 1850

19. *Asplanchna brightwelli*

Family SYNCHAETIDAE

Genus *Polyarthra* Ehrenberg 1834

- 20.
- Polyarthra vulgaris*
- Carlin

Order FLOSCULARIACEA

Suborder GNESIOTROCHA

Family HEXARTHRIIDAE

Genus *Hexarthra* Schmarda 1854

- 21.
- Hexarthra mira*
- Hudson and Gosse

Family FILINIIDAE

Genus *Filinia* Bory de St. Vincent 1907

- 22.
- Filinia longiseta*
- (Ehrenberg)

Family TESTUDINELLIDAE

Genus *Testudinella* Bory de St. Vincent 1907

- 23.
- Testudinella patina*
- (Hermann)

ARTHROPODA

Class CRUSTACEA

Subclass BRANCHIOPODA

Order CLADOCERA

Family DAPHNIDAE

Genus *Ceriodaphnia* Dana 1853

- 24.
- Ceriodaphnia cornuta*
- Sars

Genus *Daphnia* Müller 1785

- 25.
- Daphnia carinata*
- King

- 26.
- Daphnia lumholtzi*
- Sars

Genus *Scapholeberis* Schoedler 1858

- 27.
- Scapholeberis kingi*
- Sars

Family MIONIDAE

Genus *Moina* Baird 1850

- 28.
- Moina micrura*
- Kurz

Family MACROTHRICIDAE

Genus *Macrothrix* Baird 1843

- 29.
- Macrothrix spinosa*
- King

Family CHYDORIDAE

Subfamily CHYDORINAE

Genus *Chydorus* Leach 1843

30. *Chydorus sphaericus* (Muller)

31. *Chydorus barroisi* (Richard)

Genus *Dunhevedia* King 1853

32. *Dunhevedia crassa* King

Genus *Alona* Baird 1850

33. *Alona quadrangularis* (Muller)

34. *Alona rectangula* Sars

Genus *Pleuroxus* Baird 1843

35. *Pleuroxus* sp.

Subclass COPEPODA

Order CALANOIDA

Family DIAPTOMIDAE

Genus *Diaptomus* Westwood 1907

36. *Diaptomus* sp.

Order CYCLOPOIDA

Family CYCLOPIDAE

Genus *Cyclops* O.F. Muller 1776

37. *Cyclops* sp.

Genus *Mesocyclops* Sars 1914

38. *Mesocyclops varicans* (Sars)

Genus *Paracyclops* Claus 1893

39. *Paracyclops fimbriatus* (Fischer)

Subclass OSTRACODA

Order PODOCOPA

Family CYPRIDAE

Subfamily CYPRINAE

Genus *Cypris* O. F. Muller 1776

40. *Cypris* sp.

Subclass MALACOSTRACA

Order DECAPODA

Family PALAEMONIDAE

Genus *Macrobrachium* Bate 1868

41. *Macrobrachium* sp.

Protozoa : Protozoan species were represented by four genera viz. *Peridinium*, *Euglena*, *Arcella* and *Diffugia* belonging to three families, two orders and two classes of Protozoa. They were found to be very less in number and therefore insignificant.

Rotifera : Rotifers were found to be the most dominant component of zooplanktonic population both in terms of diversity and average density. They were mainly represented by eleven genera and nineteen species belonging to nine families and three orders. The genus *Brachionus* was represented by six species and had the maximum numbers per liter as compared to other genera.

Cladocera : Cladocerans were represented by nine genera and twelve species. They constituted sizeable component of the total zooplankton mass with moderate diversity.

Copepoda : Copepods were important components of zooplankton mass represented by calanoids, its nauplii and cyclops. They were regular in occurrence more or less uniformly distributed throughout the lake waters and even dominated certain sampling sites. Copepods were represented by four genera and four species under one family. The Cyclops were found to be most abundant forms of zooplankton mass regularly occurring in all sampling sites with a uniformly higher density.

Ostracoda : Cyprids were found to be very less in numbers and hence holds poor and insignificant density and seems to be represented by one species only.

Decapoda : Decapods were represented by *Macrobrachium* sp.

Insecta : Insecta was represented by larvae of Diptera (Chironomidae, Psychodidae and Culicidae), Ephemeroptera, Plecoptera, Hemiptera and Odonata (nymphs of dragon and damselflies) and many derelicts forms.

6.1.2. Insecta

Insect constitute major component of any water ecosystem. The availability of land and water and the area of interface habitat enrich both the diversity and density of the group insecta. Nalsarovar wetland being a reed wetland also has unique habitat composition having bays or islands within the water submergence area of the wetland. Insects especially aquatic and semiaquatic are also important as major food source to most wetland birds.

During the course of different surveys conducted at Nalsarovar wetland from 1999-2003, insect collections were made by sweeping insect net in the air, over vegetation and from different depths of the lake waters including immature stages. The specimens were also collected from water surface and on light traps using high luminous screen light method placed on bays within the wetland. The specimens were collected and preserved in 70% alcohol in the field, sorted out in the laboratory, labelled and processed for further studies by experts. Some of the major groups of insecta identified by various experts were Dermaptera, Orthoptera, Hemiptera, Diptera and Hymenoptera.

Demaptera, popularly known as earwigs commonly occur under stones, where a little moisture is available or on the edge of wetland. The present paper reports six species of Dermaptera, *Euborellia annulipes* (Lucas) (Family: Anisolabididae); *Nala lividipes* (Dufour), *Labidura riparia* (Pallas, 1773), *Forcipula quadrispinosa* (Dohrn, 1863), *Forcipula trispinosa* (Dohrn), *Forcipula indica* (Brindle) (Family: Labiduridae) which were collected from Nalsarovar wetland.

Orthoptera includes grasshoppers, crickets, grouse-locusts, bush-crickets etc., and Mantodea contains mantid-commonly known as praying mantids. In the present study a total of five species of Orthoptera viz. *Gryllus bimaculatus* De Geer, *Plebeiogryllus guttiventris* (Walker), *Gryllodes sigillatus* (Walker) (Family Gryllidae); *Gryllotalpa africana* Beauvois (Family: Gryllotalpidae); *Hieroglyphus nigrorepletus* Bolivar (Family: Acrididae) are recorded from Nalsarovar wetland.

The Hemiptera is represented by eleven species of aquatic bugs collected from Nalsarovar wetland, Gujarat belonging to five families: Nepidae, Notonectidae, Belostomatidae and Corixidae (true aquatic families) and Gerridae (semi-aquatic) are reported here. The species are *Lethocerus indicus* (Lepeletier & Serville.), *Diplonychus annulatum* (Fabricius), *Diplonychus rusticus* (Fabricius)* (Family Belostomatidae); *Ranatra filiformis* Fabricius (Family Nepidae); *Anisops campbelli* Brooks, *Anisops cavifrons* Brooks (Family Notonectidae); *Agraptocorixa (Agraptocorixa) hyalinipennis* (Fabricius), *Micronecta (Sigmonecta) quadristrigata* Breddin, *Micronecta (Basilonecta) scutellaris scutellaris* (Stal) (Family Corixidae); *Aquarius adelaidis* (Dohrn), *Limnogonus (Limnogonus) fossarum fossarum* (Fabricius) (Family: Gerridae) (Appendix 2).

The present study records twenty-three species of Diptera belonging to nineteen genera under ten families from Nalsarovar wetland, Gujarat. The Diptera species belonging to different families were collected from diverse habitats i.e. *Psychoda alternata* Say, *Clogmia albipunctata* (Williston) (Psychodidae); *Adoxomyia heminopla* (Wiedemann), *Sargus metallinus* (Fabricius), *Ptecticus australis* Schiner, *Oplodontha rubrithorax* (Macquart) (Family: Stratiomyidae); *Tabanus (Tabanus) striatus* (Fabricius); *Tabanus (Tabanus) leucohirtus* Ricardo, *Tabanus (Tabanus) indianus* Ricardo (Family Tabanidae); *Stichopogon indicus* Joseph and Parui, *Stichopogon meridionalis* Oldroyd (Family: Asilidae); *Anthrax distigma* Weidemann, *Anthrax bipunctatus* (Fabricius), *Exoprosopa (Exoprosopa) insulate* Walker (Family Bombyliidae); *Dicrotendipes* sp., *Chironomus* sp., *Polypedilum angustiforceps* Kieffer, *Cricotopus pentazonus* (Kieffer) (Family Chironomidae); *Eristalinus (Eristalinus) arvorum* (Fabricius), *Episyrphus balteatus* (De Geer) (Family Syrphidae); *Hippobosca variegata* Megerle (Family Hippoboscidae); *Musca (Musca) domestica* Linnaeus (Family Muscidae); *Chrysomya megacephala* (Fabricius) (Family Calliphoridae).

The chironomid midges belonging to order Diptera is a major component of insect fauna of the Nalsarovar wetland. The larvae of the family chironomidae are planktonic in nature and also constituent the benthic component of the lakebed. They also form an important food source of fishes and birds. The increasing urbanization of areas surrounding Nalsarovar has

resulted in eutrophication of water making possible increased production of dipterans. The even greater load of nutrient materials which are added to the lake waters from domestic sewage, industry and crop fertilizers result in a situation ideally suited for the production of many pollution indicator species of midges. They emerge in such large numbers so as to produce "pest swarms" The adult Chironomidae appear on the wings just after emergence and exhibit specific swarming behaviour in the air. Sometimes they swarm in such large numbers that they may effectively discourage the use of such areas for recreation and summer homes.

Two species of ants under two genera *Monomorium* (*Xeromyrmex*) *salomonis indicum* Forel (Subfamily: Formicinae) and *Camponotus* (*Tanaemyrmex*) *compressus* Fabricius (Subfamily: Myrmicinae) of Family Formicidae of order Hymenoptera were also recorded from the wetland.

The large assemblage of specimens collected belonging to different families of Insecta viz. Collembola (springtails), Ephemeroptera (mayflies), Odonata (dragonflies & damsel flies)), Dictyoptera, Neuroptera (alder flies, lacewings & antlions), Mecoptera (Scorpion flies), Lepidoptera (Rhopalocera & Heterocera), Hymenoptera (ichneumon flies, wasps, hornets, and bees), Coleoptera (beetles), are still to be identified by the experts.

6.2. VERTEBRATE FAUNA

6.2.1. Ichthyofauna

Inland fisheries is a major source of protein rich food not only to human population but also a treasure resource for many wildlife species to depend on, especially birds and mammals. Most wetlands especially those connected with rivers or canals have self sustaining inflow of fish species regulated by supply of water from the catchment. Nal wetland is a glaring example of such self regulated ichthyofauna. But due to nonperennial water source and shallowness of the lake has resulted in having less diversity with relatively low abundance of the fish fauna along with serious commercial exploitation of the fish resource. Earlier 19 species were reported from the wetland. The present account records 28 species based on collection made during various surveys of Nalsarovar wetland, Gujarat. The species are **Salmostoma bacaila* (Ham.), **Salmostoma clupeioides* (Bloch.), **Parluciosoma daniconius* (Ham.), **Puntius sophore* (Ham.), *Puntius sarana sarana* (Ham.), **Hypseobarbus jerdoni* (Day), *Cirrhinus mrigala* (Ham.), *Catla catla* (Ham.), **Labeo bata* (Ham.), *Labeo calbasu* (Ham.), *Labeo rohita* (Ham.), **Labeo fimbriatus* (Bloch.) (Family Cyprinidae); **Lepidocephalus guntea* (Ham.) (Family Cobitidae); **Mystus cavasius* (Ham.), **Mystus montanus* (Jerdon), **Mystus gulio* (Ham.) (Family Bagridae); **Ompok pabda* (Ham.), *Wallago attu* (Sch.) (Family Siluridae); *Heteropneustes fossilis* (Bloch.) (Family Heteropneustidae); **Xenentodon cancila* (Ham.) (Family Belontiidae); **Macrogathus pancalus* (Ham.), **Macrogathus aculeatus* (Bloch.) (Family Mastacembelidae); **Chanda nama* (Ham.), **Pseudambassis ranga* (Ham.) (Family Ambassidae); **Glossogobius giuris* (Ham.) (Family Gobiidae); **Channa orientalis* (Bloch & Sch.), **Channa punctatus* (Bloch.), *Channa striatus* (Bloch.) (Family Channidae) (Appendix 3).

Whereas the species reported earlier but not recorded during the present study are *Puntius sp.*, *Puntius ticto* (Ham-Buch), *Cirrhinus cirrhosa* (Bloch), *Cyprenus caprio* (Linnaeus), *Garra mullya* (Sykes) (Family Cyprinidae); *Mystus shingala* (Family Bagridae); *Saccobranthus sp.* = *Heteropneustes sp.* (Family: Heteropneustidae); *Channa marulius* (Ham-Buch), *Channa chanos* (Forsskal) (Marine, estuarine), *Ophiocephalus sp. 1* = *Channa sp. 1.*, *Ophiocephalus sp. 2* = *Channa sp. 2.* (Family: Channidae); *Clarias sp.* (Family Claridae); *Tilapia mossambica* = *Oreochromis mossambica* (Peters) (Family Cichlidae); *Tylosurus strongylura* = *Strongylura strongylura* (Van Hasselt) (Inhabits coastal water enter estuaries freely) (Family Belonidae). Species marked with * are recorded for the first time from the wetland.

6.2.2. Amphibia

Amphibian fauna of Nalsarovar has not been studied so far. The present paper describes total seven species of frogs and toads (Plate 3). More intensive surveys shall further enrich the amphibian fauna from this wetland as well as Gujarat. Classifications followed are that of Boulenger (1920), Parker (1934), Daniel (1963) and Chanda (2002).

SYSTEMATIC LIST

Class AMPHIBIA

Order ANURA

Family RANIDAE

1. **Haplobatrachus tigerina* (Daudin)
2. **Euphlyctis cyanophlyctis* (Schneider)
3. **Euphlyctis hexadactyla* Lesson
4. **Limnonectes limnocharis* Weigmann

Family BUFONIDAE

5. **Bufo stomaticus* Lutken Smith
6. **Bufo melanostictus* Schneider

Family MICROHYLIDAE

7. **Microhyla ornata* (Dumeril and Bibron)

SYSTEMATIC ACCOUNT

Class AMPHIBIA

Order ANURA

Family RANIDAE

1. *Haplobatrachus tigerina* (Daudin)
Indian Bull Frog

2002. *Haplobatrachus tigerina* (Daudin) Chanda, *Hand Book-Indian Amphibians: i-viii*, pp. 136.

Material examined : 2 ex., 23.x.2001, Durgi, Nalsarovar wetland, Reg. No. 782/6, coll: S. Kumar.

Diagnostic characters : Largest of all Indian frog. Normally it is olive brown above but may be greenish marked with characteristic dark spots. One light yellow vertebral stripe from snout to vent which may be rarely absent in some specimens. A strong glandular fold extending from eye to the shoulder present. Snout more or less pointed. First finger is longer than the second.

Distribution : All over India from base of Himalayas to South including Andamans except Meghalaya.

Elsewhere : Sri Lanka, Myanmar, Thailand, South China, Taiwan, Nepal, Pakistan and Bangladesh.

Remarks : Common. Very large size frog and hide under the cover of thick aquatic vegetation and water holes.

2. *Euphlyctis cyanophlyctis* (Schneider)

Skipping Frog

2002. *Euphlyctis cyanophlyctis* (Schneider) Chanda, *Hand Book Indian Amphibians: i-viii*, pp. 98.

Material examined : 4 exs., 13.xii.2002, Devthali, Nalsarovar wetland, Reg. No. 295/6, coll: S. Kumar.

Diagnostic characters : It is a medium sized frog with a length of around 65 cm from snout to vent. Upper dorsum is olive brown with dark markings and rows of pores but ventral side is almost smooth. A more or less distinct, dark, light edged band present above each flank even on the upper and lower margins of thigh. Proportionally longer thigh, two blackish streaks on the hind side of the thighs are always present. Dark spots on the limbs.

Distribution : All over India except Meghalaya.

Elsewhere : Nepal, Sri Lanka, Pakistan, Bangladesh and Thailand.

Remarks : Commonly available in all districts of Gujarat.

3. *Euphlyctis hexadactyla* Lesson

Pond Frog

1834. *Rana hexadactyla* Lesson in Baling, *Voy. Indian or Rept.*, : 331.

1920. *Rana hexadactyla*: Boulenger, *Rec. Indian Mus.*, 20 : 10-11.

1984. *Rana hexadactyla*: Sarkar, *Bull. zool. Surv. India*, 6(1-3) : 87.

2002. *Euphlyctis hexadactyla* Lesson, Chanda, *Hand Book- Indian Amphibians: i-viii*, pp. 99.

Material examined : 1 ex., 30.iii.1999, Nana Chera Bet, Nalsarovar wetland, Reg. No. 14/6, coll : S. Kumar.

Diagnostic characters : Head as long as broad or a little broader than long; Dorsum leaf-green or darker with porous warts, venter dull whitish. Throat with granular warts, lateral sides of belly and under the thighs. Tympanum distinct.

Distribution : India : West Bengal, Orissa, Rajasthan, Gujarat (Halwad, Jamnagar, Surat, Navsari, Bulsar, Dangs and Bharuch), Goa, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and Kerala.

Elsewhere : Sri Lanka, Pakistan and Bangladesh.

Remarks : Species is not so common.

4. *Limnonectus limnocharis* Weigmann 1835 Cricket Frog

1835. *Rana limnocharis* Weigmann, *N. Acta Ac. Leop. Carol.* 17.

1920. *Rana limnocharis*: Boulenger, *Rec. Indian Mus.*, 20 : 28.

1984. *Rana limnocharis*: Sarkar, *Bull. zool. India*, 6(1-3) : 89.

Material examined : 6 exs., 21.x.2001, Nalsarovar (openwaters), Reg. No. 787/6 coll. S. Kumar.

Diagnosis : Head as long as broad, snout pointed projecting beyond mouth, nostril nearer to the tip of snout than to eye, tympanum distinct, fingers free, first longer, second smaller than first, tips swollen. Toes distinct, half webbed. Dorsum greyish and with warts. Venter whitish and smooth.

Distribution : India : All biotopes of India, Rajasthan, Gujarat (Kuchchh, Banaskantha, Mahesana, Sabarkantha, Ahmedabad, Bhavnagar, Amreli, Junagadh, Kheda, Panchmahal, Vadodra, Baruch, Surat, Dangs and Valsad.

Elsewhere : Eastern Asia from Pakistan, Nepal, Bangladesh, Sri Lanka and China to Japan.

Remarks : Common. Abundantly found in Nalsarovar and a good food for many water birds.

Family BUFONIDAE

5. *Bufo stomaticus* Lutken Marbled Toad

2002. *Bufo stomaticus* Lutken Smith, Chanda, *Hand Book- Indian Amphibians: i-viii*, pp. 28.

Material examined : 3 exs., 15.x.2001, Dharabala Bet, Nalsarovar wetland, Reg. No. 327/6, coll. S. Kumar.

Diagnostic characters : Large sized toad, Dorsal surface of the body tuberculated and ventral surface coarsely granulated. Tympanum distinct.

Distribution : India: Plains of India from Kashmir to Karnataka and Assam in the east, Gujarat (Kuchchh, Banaskantha, Mahesana, Sabarkantha, Jamnagar, Rajkot, Bhavnagar, Amreli and Kheda).

Elsewhere : Nepal, Myanmar, Sri Lanka, Pakistan and Arabia.

Remarks : Species is common.

6. *Bufo melanostictus* Schneider Common Indian Toad

1962. *Bufo melanostictus* Schneider, *Hist. Amph.* 1 : 216.

2002. *Bufo melanostictus* Schneider, Chanda, *Hand Book-Indian Amphibians: i-viii*, pp. 25.

Material examined : 3 exs., 16.x.2001, Bansori Bet, Nalsarovar wetland, Reg. No. 301/6, coll. S. Kumar.

Diagnostic characters : The dorsal surface of the body brown to yellowish brown with prominent and spiny warts. Tympanum very distinct and close to the eyes. Tips of fingers and toes are blunt.

Distribution : India Common throughout the plains of India, Rajasthan, Gujarat (Sabarkantha, Rajkot, Junagad, Kheda, Panchmahal and Bharuch), Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Maharashtra, West Bengal.

Elsewhere : Nepal, Sri Lanka, Pakistan, Bangladesh, Myanmar, South China, Malaya Peninsula and Archipelago.

Remarks : Species is common.

Family MICROHYLIDAE

7: *Microhyla ornata* (Dumeril and Bibron) Ornate Microhylid

1890. *Microhyla ornata* Boulenger, *Fauna, British. India Including Ceylon and Burma, Reptilia & Batrachia* : 165.

2002. Chanda, *Hand Book Indian Amphibians: i-viii*, pp. 41.

Material examined : 1 ex., 19.ii.2000, Mulbavala, Nalsarovar wetland, Reg. No. 223/6, coll. S. Kumar.

Diagnostic characters : Small sized frog, fingers and toads are slender with their tips dilated into small discs. Dorsal surface with a dark marking on back extending posteriorly between the eyes. A dark streak extending from behind the eyes up to the shoulder. The pupil is erect and the tongue is elliptical.

Distribution : Widely distributed all over India, Andaman Islands, Gujarat (Banaskantha, Bhuj, Bharuch, Dangs, Sabarkantha, Jamnagar, Rajkot, Surendranagar, Ahmedabad, Bhavnagar, Amreli and Kheda).

Elsewhere : Pakistan, Nepal, Bangladesh, Myanmar, Sri Lanka, Southern China and Indo-China.

Remarks : Common in Nalsarovar, moist patches and ditches with dry leaves and stony habitats are the hiding places for this species. As soon as the heaps of leaves and stones are turned up, they start jumping and try to quickly hide in safer places.

6.2.3. Reptilia

The present study is based on sightings of animals in the field and a small collection of reptiles especially lizards (though not an integral component) made from Nalsarovar wetland and its surroundings from 1999 - 2003. The collection comprises sixteen species of reptiles, which includes turtles, lizards and snakes (Plate 4). Fifteen species are common to Oriental and Palearctic Regions and one species is exclusively endemic to Indian region. The classification followed is that of Sharma (1998) for testudines and crocodilia; Tikader and Sharma (1992) for lizards; Sharma (2002 & 2003) for serpents. Species marked with asterisk * are first records from Nalsarovar wetland.

SYSTEMATIC LIST

Order TESTUDINES

Family TRIONYCHIDAE

1. *Lissemys punctata punctata* (Lacepede) 1788, North Indian Flap-Shelled Turtle

Order SQUAMATA

Suborder SAURIA

Family GEKKONIDAE

2. **Hemidactylus brooki* Gray 1848, Spotted Indian House Gecko
3. **Hemidactylus leschenaulti* Dumeril and Bibron, 1836, Bark Gecko
4. *Hemidactylus flaviviridis* Ruppell 1835, Yellow Bellied House Gecko

Family AGAMIDAE

5. *Calotes versicolor* (Daudin 1802) Indian Garden Lizard

Family SCINCIDAE

6. *Mabuya carinata* (Schneider 1801) Common Brahminy Skink

Family LACERTIDAE

7. **Ophisops jerdoni* Blyth 1853, Golden Striped Lizard
8. **Ophisops microlepis* Blanford 1870, Snake Eyed Lizard

Family VARANIDAE

9. *Varanus bengalensis* (Linnaeus 1758) Indian Monitor

10. **Varanus salvator* (Laurenti 1768) Water Monitor

Suborder SERPENTES

Family BOIDAE

11. *Eryx johnii* (Russell) 1801. Red Sand Boa/Golden Sand boa

Family COLUBRIDAE

12. *Ptyas mucosus* (Linnaeus 1758) Indian Rat Snake

13. *Xenochrophis piscator* Schneider 1799, Checkered Keel-back Water Snake

Family ELAPIDAE

14. *Bungarus caeruleus* (Schneider 1801) Common Krait

15. *Naja naja* (Linnaeus 1758) Black Cobra/Spectacled Cobra

Family VIPERIDAE

16. *Echis carinatus* (Schneider 1801) Saw-scaled Viper

SYSTEMATIC ACCOUNT

Order TESTUDINES

Family TRIONYCHIDAE

Genus *Lissemys* Smith 1931

1. *Lissemys punctata punctata* (Lacepede 1788)

1788. *Lissemys punctata punctata* Lacepede, La Tortue chagrinee, *Hist. Quad. Ovip.*, 1 : 171, pl. 11.

1931. *Lissemys punctata punctata*, Smith, *Fauna Brit. Ind.*, 1 : 157.

Material examined : 2 exs. live, 29.iii.1999, in a water channel from Nal sarovar to Durgi village for irrigation; 1 ex. live, 19.x.2001, water channel in the Parali area; 1 ex., in the main Nal sarovar area near FGH; 9 exs., dead, 4.iii.2003, carapace found in the Nal adjacent to Meni village area on a dried bed of Nalsarovar recorded by S. Kumar.

Diagnostic characters : A small turtle with moderately large head, short and broad snout. The carapace and plastron covered by a continuous sheet of soft skin. Plastron is with soft, semicircular flaps. Limbs are fully webbed with only three claws on each foot. Tail short, olive brown above. Carapace grey-green with numerous black bordered yellow spots.

Distribution : India : Andaman Islands, Ganga river system, Gujarat (Kutch) and Sikkim.

Elsewhere : Bangladesh, Myanmar, Nepal, Pakistan (Sind river system) and Sri Lanka.

Remarks : Species common to Oriental and Palaearctic Regions. Suspected to be threatened on account of ruthless killing and overexploitation of adults and their eggs for protein rich food.

Order SQUAMATA
Suborder SAURIA
Family GEKKONIDAE

Genus *Hemidactylus* Oken 1817

2. *Hemidactylus brooki* Gray 1848

1935. *Hemidactylus brooki* Smith, *Fauna Brit. Ind.*, 2 : 89.

Material examined : 1 ex., 29.iii.1999, Ranagarh W. T.; 1 ex., 31.iii.1999, Mota Chera Bet, coll.: S. Kumar.

Diagnostic characters : A light brown and dark black spots due to powdery scales. Head large, ovate and prominent. Eyes are with vertical pupil.

Distribution : India : Widely distributed in whole of the India.

Elsewhere : Sri Lanka, Borneo, Pakistan, Burma, South China, West Indies, Tropical Asia and northern half of Africa.

Remarks : Species is very common to Oriental and Palaeartic Regions. It is new record from Nalsarovar.

3. *Hemidactylus leschenaulti* Dum. and Bibr. 1836

1935. *Hemidactylus leschenaulti* Smith, *Fauna Brit. Ind.*, 2 : 97.

Material examined : 1 ex., 27.iii.1999, Pan Bet; 1 ex., 15.x.2001, Dharabla Bet, coll. S. Kumar.

Diagnostic characters : Ashy grey gecko with cross bars or undulating cross bars on the dorsal part of the body. Head is large with a broad snout, covered with small granular scales. Nostril is situated between rostral.

Distribution : India: Widely distributed in Rajasthan, Peninsular India and west Bengal.

Elsewhere : Sri Lanka, Pakistan.

Remarks : Species is abundant and very common. It is new record from Nalsarovar.

4. *Hemidactylus flaviviridis* Ruppell 1835

1935. *Hemidactylus flaviviridis* Smith, *Fauna Brit. Ind.*, 2 : 98.

Material examined : 2 exs., 14.ii.2000; 1 ex., 12.xii.2000, Forest Guest House, Nalsarovar; 1 ex., 3.iii.2003, Ranagadh W.T., coll. : S. Kumar

Diagnostic characters : Head large swollen at the corners near tympanum and jaws, covered with minute granules. Ear opening is sub-circular. Nostril is situated between nasals.

Distribution : India : Whole of India.

Elsewhere : Arabia, Pakistan, Iran and shores of the red sea.

Remarks : Species is very common to Oriental and Palaeartic Regions.

Family AGAMIDAE

Genus *Calotes* Rafinesque 18155. *Calotes versicolor* (Daudin 1802)1935. *Calotes versicolor* Smith, *Fauna Brit. Ind.*, 2 : 189.

Material examined : 1 ex., 15.ii.2000, Pan Bet; 1 ex., 13.xii.2000, Ranagadh; 1 ex., 20.x.2001, Basori Bet, coll. : S. Kumar.

Diagnostic characters : A large and robust gecko with pale bars on dorsum and yellowish belly. Head is large with a broad snout. Eyes are large, digits long strong slightly curved at angles.

Distribution : India: Whole of India but widely distributed in north India.

Elsewhere : Sumatra to South China, Sri Lanka, Pakistan and Afghanistan.

Remarks : Species is most common to Oriental and Palaeartic Regions.

Family SCINCIDAE

Genus *Mabuya* Fitzinger 18266. *Mabuya carinata* (Schneider 1801)1935. *Mabuya carinata* Smith, *Fauna Brit. Ind.*, 2 : 266.

Material examined : 1 ex., 30.iii.1999, Brahmi river Bridge area; 1 ex., 23.x.2001, Durgi, coll. S. Kumar.

Diagnostic characters : Brown olive brown or shining bronze. Tongue is long and elastic. Back and antero-dorsal portion of tail is with dark brown spots or longitudinal lines along the lateral margins of scales.

Distribution : India: Indian Peninsula, Gujarat, Assam and Bengal.

Elsewhere : Sri Lanka and Nepal.

Remarks : Species is very common.

Family LACERTIDAE

Genus *Ophisops* Menetries 18327. *Ophisops jerdoni* Blyth 18531935. *Ophisops jerdoni* Smith, *Fauna Brit. Ind.*, 2 : 377.

Material examined : Many specimens were recorded from the Ranagadh area near watch Tower and towards village area in year 2000 and 2003.

Diagnostic characters : Dorsum olive brown with a golden tinge, with 2 golden lateral stripes. Upper head shields strongly keeled, nostril is in a large nasal shield. Pre frontals in contact with each other. Temporal scales are strongly keeled.

Distribution : India: Rajasthan, Tamil Nadu, Andhra Pradesh, Madhya Pradesh and Gujarat.

Elsewhere : Pakistan.

Remarks : Species is very common. It is new record from Nalsarovar.

8. *Ophisops nicrolepis* Blanford 1870

1935. *Ophisops microlepis* Smith, *Fauna Brit. Ind.*, 2 : 380.

Material examined : 1 ex., 26.iii.1999, FGH, Nalsarovar, 1 ex., 3.iii.2003, Pan Bet, coll.: S. Kumar.

Diagnostic characters : Dorsum is olive greenish or brownish with golden stripes and sides of neck and flanks are densely spotted.

Distribution : India : Rajasthan, Bihar, Gujarat and Madhya Pradesh.

Remarks : Species is very common. It is new record from Nalsarovar.

Family VARANIDAE

Genus *Varanus* Merrem 1820

9. *Varanus bengalensis* (Linnaeus 1758)

1758. *Lacerta monitor* Linnaeus, *Syst. Nat. Ed.*, 10 : 201 (type loc. India).

1885. *Varanus bengalensis*, Boulenger, *Cat. Liz. Brit. Mus.*, p. 10 (type loc. India).

1935. *Varanus monitor*, Smith, *Fauna Brit. Ind.*, 2 : 402.

1966. *Varanus bengalensis*, Monton, *Bull. Amer. Mus. Nat. Hist.*, 134 : 112.

Material examined : 9 times the animal was recorded from Nani Katchi, Ranagadh, Borathali, Bajoth, Jambuthali, Mulbavala, Parali area adjacent to the Nal and near the FGH of Nalsarovar area in the years 1999, 2000, 2001 and 2003.

Diagnostic characters : Sandy brown with cylindrical tail. A prominent dark streak is present on the eye; Nostril is an oblique slit nearer to the orbit than to the snout; Ventrums are whitish with thin dark transverse bars. Tail is compressed with a low double-toothed dorsal crest.

Distribution : India: Throughout.

Elsewhere : Burma, Sri Lanka, Pakistan, Nepal and Uzbekistan.

Remarks : Species is very common. Endangered species. They are being killed in large numbers for their skin and flesh.

10. *Varanus salvator* (Laurenti 1768)

1768. *Stellio salvator* Laurenti, *Syn. Rept.*, (based on seba's Illustration 2, pl. 88, fig. 21).

1935. *Varanus salvator*, Smith, *Fauna Brit. India*, 2 : p. 406.

Material examined : 1 ex., 16.x.2001, Basori Bet; 1 ex., adult live and 1 ex., juvenile live, 2.iii.2003, Dharabala Bet recorded by S. Kumar.

Diagnostic characters : Nostril is an round or oval nearer to the end of the snout than to

the orbit; Snout depressed; Abdominal scales are feebly keeled, in 80-95 rows; Tail strongly compressed with a low toothed crest above. Diurnal and more aquatic in habitat. It can climb on trees in search of food. Eggs laid in the holes on banks or rivers, in trees besides the water bodies.

Distribution : India : Gujarat, Andaman and Nicobar islands; eastern part of Bengal; Eastern Himalayas upto 6000 ft., Sundarbans and Cochin.

Elsewhere : Sri Lanka, Bangladesh, Borneo, Burma, Cambodia, China (South), Pakistan, Philippines, Malayan region, Myanmar, East Indian Archipelago, North Australia, Thailand and Vietnam.

Remarks : Vulnerable. Killed for its skin and eggs which are said to taste like turtle eggs. Species is exclusively endemic to the India subregion. It is new record from Nalsarovar, Gujarat.

Suborder SERPENTES

Family BOIDAE

Genus *Eryx* Daudin 1803

11. *Eryx johnii* (Russell 1801)

1801. *Boa johni* Russell, *Ind. Serp.*, 2 : 18 & 20, pls. 26 & 27.

1943. *Eryx johni johni*, Smith, *Fauna Brit. Ind.*, 3 : 113.

Material examined : 1 ex., dead, 12.xii.2000, road kill, entrance of the FGH, Nalsarovar recorded by S. Kumar.

Diagnostic characters : Body cylindrical, dorsal colouration is geryish bronze, slight pale mottling on the flanks with indistinct and light coloured pale rings. Snake is docile and sluggish.

Distribution : India: Rajasthan, Gujarat Andhra Pradesh, Uttar Pradesh, Maharashtra, Tamil Nadu and Punjab.

Elsewhere : Sri Lanka, Pakistan, Afghanistan and Iran.

Remarks : Species is very common.

Family COLUBRIDAE

Genus *Ptyas* Fitzinger 1843

12. *Ptyas mucosus* (Linnaeus 1758)

1758. *Coluber mucosus* Linnaeus, *Mus. Ad. Frid.*, 1 : 37.

1943. *Ptyas mucosus*, Smith, *Fauna Brit. Ind.*, 3 : 159.

Material examined : 1 ex., live, 28.ii.2003, Brahmni river side Dam construction, 1 ex., live, 3.iii.2003, near Ranagadh W. T. recorded by S. Kumar.

Diagnostic characters : Head quite distinct from the neck. Top of the head is devoid of

spots. Ventrums are creamish or turbid white, free edges of the ventrals and sub-caudals are blackish.

Distribution : Whole of India.

Elsewhere : South China, Vietnam, Iran, Southern Afghanistan to Transcaspia, Sri Lanka, Java, Sumatra, Malaysia, Taiwan and Pakistan.

Remarks : Species is very common.

Genus *Xenochrophis* Gunther 1864

13. *Xenochrophis piscator* Schneider 1799

1799. *Hydrus piscator* Schneider, *Hist. Amph.*, 1 : 247.

1943. *Natrix piscator*: Smith, *Fauna British India*, 3 : 293.

1965. *Xenochrophis piscator* Malnate and Minton. *Proc. Acad. Nat. Sci. Phila.*, 117 : 19-41.

Material examined : 2 exs., live, 30.iii.1999, Brahmani river; 2 exs., live, 20.x.2001, Ranagadh, 1 ex., live, 23.x.2001, Durgi (adjacent to Nal) recorded by S. Kumar

Diagnostic characters : Head oval, distinct from neck, slightly flattened with a blunt pointed snout, eyes large with round pupil. Colour varies from yellowish, olive, light green, grey-brown with a reddish tinge, with five rows of small light black spots, head olive brown with two oblique black streaks one below the other behind the eye.

Distribution : India : Widely distributed throughout.

Elsewhere : Bangladesh, Borneo, Burma, Malayan region, Myanmar, Pakistan, South China, Sri Lanka and Taiwan.

Habit and Habitat : A water snake found in all types of aquatic habitat and a fast swimmer. They defend themselves by diving or swimming away from the enemies or by means of emitting foul smelling anal secretion. These snakes mainly feed on amphibians, fishes, small crustaceans and aquatic insects.

Remarks : Species is very common.

Family ELAPIDAE

Genus *Bungarus* Daudin 1803

14. *Bungarus caeruleus* (Schneider 1801)

2007. Sharma, *Fauna of India : Reptilia (Serpentes) Vol. III*. pp. 292.

Material examined : 1 ex., live, 4.iii.2003, Panali area adjacent to Nal recorded by S. Kumar.

Diagnostic characters : Head is not distinct from the neck with blunt and flat snout. Ventrums are wheatish, scales round the body are in 15 or 17 rows.

Distribution : India: Rajasthan, Gujarat, Andhra Pradesh, Uttar Pradesh, Punjab, Haryana, Orissa, Maharashtra, Karnataka, Peninsular India, Madhya Pradesh, Tamil Nadu, and Kerala.

Elsewhere : Sri Lanka and Pakistan.

Remarks : Species is becoming rare on account of habitat loss throughout in Oriental and Palaeartic Regions.

Genus *Naja* Laurenti 1766

15. *Naja naja* (Linnaeus 1758)

1758. *Coluber naja*, Linnaeus, *Syst. Nat.*, : 221.

1943. *Naja naja naja*, Smith, *Fauna Brit. India.*, 3 : 427.

Material examined : 1 ex., live, 28.iii.2003, in the dried margins of Nal near Shahpur recorded by S. Kumar.

Diagnostic characters : Head is quite wide, spectacle mark on dorsal aspect of hood. Ventral side of hood is width 2 to 4 irregular, dark, transverse bars in many individuals it is uniformly dark. It is sub-cylindrical posteriorly dorsoventrally flattened.

Distribution : India : Rajasthan, Gujarat, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Goa, Punjab, Haryana, Orissa, Maharashtra, Karnataka, Tamil Nadu, West Bengal, Kashmir, Bihar and Kerala.

Elsewhere : Sri Lanka.

Remarks : Species is very common. Population is declining due to its habitat destruction and killing.

Family VIPERIDAE

Genus *Echis* Merrem 1820

16. *Echis carinatus* (Schneider 1801)

1943. *Echis carinatus*, Smith, *Fauna Brit. Ind.*, 3 : 487.

Material examined : 1 ex., live, 29.iii.1999, Ranagadh village area recorded by S. Kumar.

Diagnostic characters : Dorsal aspect of head with an arrow mark which is distinct, eyes are large. Its diameter is greater than its distance from the mouth, surrounded by 13-21 small scales. The outermost row of scales is largest.

Distribution : India: Rajasthan, Gujarat, Andhra Pradesh, Goa, Maharashtra, Karnataka, Tamil Nadu, Jammu and Kashmir. Elsewhere: Arabia, Ghana, Kenya, Nigeria, Sri Lanka, Iran, whole of middle east, southern portion of Russia Asia, Pakistan and Iraq.

Remarks : Species is very common throughout its range of distribution in Oriental and Palaeartic Regions.

6.2.4. Aves

Nalsarovar, an Important Bird Area (IBA) located at the junction of Saurashtra plateau and mainland of Gujarat is a heaven of wintering waterfowls in India. Nal sanctuary with a

shallow inundation of water on a vast expanse of land with variety of habitats invites nearly 250 species of birds to roost, breed and over-winter in the lap of reed supported wetland ecosystem. From deep open water habitat to fallow and woodland habitat surrounding the Nalsarovar wetland, it harbours eight habitat types in its area of inundation.

Nalsarovar was declared as bird sanctuary as early as 1969 and considered on priority for conservation by the Ministry of Environment and Forest, Govt. of India due to its being the largest natural shallow water bird sanctuary supporting vast diversity of waterfowls and other available species and animal diversity. It was proposed a Ramsar site and also included in the list of important wetland of the country for conservation under A4iv criteria i.e. site known or thought to exceed thresholds set for migratory species at bottleneck sites. Nalsarovar has also been identified as Important Bird Areas in India-Gujarat with IBA site code: IN-GJ-09 (Islam and Rahamani, 2004). As Nalsarovar falls in the migratory route, hundreds of thousands of birds stop over before spreading out in the rest of Gujarat (and parts of India). Over 2,24,000 birds were recorded in 1992 and over 1,41,000 birds in 1996 census conducted by the Forest Department (Singh, 2001).

Avifaunal profile using remote sensing has been studied by Tatu (1995), Parasharya, *et al.* (1999) who reported the presence of little gull from Nalsarovar, Gujarat. About 250 species of birds including 158 species of waterfowl have been documented so far from Nalsarovar GEER (1998), Dutta (2000), Singh (2001) and Islam and Rahamani (2004). Biodiversity conservation of Nalsarovar using remote sensing techniques was studied by Garg (2002 b). Some other publications mentioning birds visiting and breeding at Nal are by Koning and Koning-Raat (1975); De Block (1981); Gole (1984a, 1984b); Khacher *et al.* (1987); Anon. (1990-2000); Singh (1998) and Bhartiya (2002).

In the present study 246 avian species are reported from Nalsarovar. 132 species are completely aquatic, 7 species are wetland dependant & associated birds, 27 species are categorized as reed dwellers and 80 species of aves are passerines from Nalsarovar and its surrounding sanctuary area. The birds marked with asterik * are new records from Nalsarovar. Birds marked with sign ~ were not recorded during the present survey but reported earlier are also included in the list to have the comprehensive data on the avian diversity of 277 species listed in wetland birds of Nalsarovar wetland, wetland dependent and associated birds, reed dwellers (Appendix 4) and passerine birds (Appendix 5). Birds were identified based on physical features with the help of field guides and reference books (Ali and Ripley, 1983; Grimmett *et al.*, 1998). Classification followed is that of Manakadan and Pittie (2001). The habitat preference of wetland birds is shown in Fig. 11 to Fig. 18. The status is given in table 11.

Nalsarovar supports a number of threatened, vulnerable, conservation dependant and near threatened avian species. A number of avifauna breeds in its reed beds and standing trees of *Acacia nilotica*, *Prosopis juliflora* etc. Planting of trees like *Acacia nilotica*, *Prosopis cineraria*, *Salvadora persica* and *Salvadora oleoides*, *Ficus* sp. *Azadirachta indica*, *Tamarandus indica* on the beds and surrounding area for nesting and roosting sites of avian species may enhance their breeding and population number in this pristine environment. Perpetuation of reeds needs to be ensured by combating over exploitation and judicious use and plantation.

WETLAND BIRDS OF NALSAROVAR WETLAND, GUJARAT

PODICIPEDIFORMES

PODICIPEDIDAE : GREBES

1. Little Grebe, *Tachybaptus ruficollis* (Pallas, 1764) +
2. Great Crested Grebe, *Podiceps cristatus* (Linnaeus, 1758) +
3. Black-necked Grebe, *Podiceps nigricollis* Brehm, 1831 +

PELECANIFORMES

PELECANIDAE : PELICANS

4. Great White Pelican, *Pelecanus onocrotalus* Linnaeus, 1758 +
5. Spot-billed Pelican, *Pelecanus philippensis* Gmelin, 1789 +
6. Dalmatian Pelican, *Pelecanus crispus* Bruch, 1832 +

PHALACROCORACIDAE : CORMORANTS/SHAGS

7. Little Cormorant, *Phalacrocorax niger* (Vieillot, 1817) +
8. Indian Shag, *Phalacrocorax fuscicollis* Stephens, 1826 +
9. Great Cormorant, *Phalacrocorax carbo* (Linnaeus, 1758) +

ANHINGIDAE : DARTER

10. Darter, *Anhinga melanogaster* Pennant, 1769 +

CICONIIFORMES

ARDEIDAE : HERONS, EGRETS & BITTERN

11. Little Egret, *Egretta garzetta* (Linnaeus, 1766) +
12. Western Reef-Egret, *Egretta gularis* (Bosc, 1792) *
13. Grey Heron *Ardea cinerea* Linnaeus, 1758 +
14. Purple Heron, *Ardea purpurea* Linnaeus, 1766 +
15. Large Egret, *Casmerodius albus* (Linnaeus, 1758) +
16. Median Egret, *Mesophoyx intermedia* (Wagler, 1829) +
17. Cattle Egret, *Bubulcus ibis* (Linnaeus, 1758) +
18. Indian Pond-Heron, *Ardeola grayii* (Sykes, 1832) +
19. Little Green Heron, *Butorides striatus* (Linnaeus, 1758) +
20. Black-crowned Night-Heron, *Nycticorax nycticorax* (Linnaeus, 1758) +
21. Little Bittern, *Ixobrychus minutus* (Linnaeus, 1766) *
22. Yellow Bittern, *Ixobrychus sinensis* (Gmelin, 1789) +
23. Chestnut Bittern, *Ixobrychus cinnamomeus* (Gmelin, 1789) +
24. Great Bittern, *Botaurus stellaris* (Linnaeus, 1758) +

CICONIIDAE : STORKS

25. Painted Stork *Mycteria leucocephala* (Pennant, 1769) +
26. Asian Openbill-Stork, *Anastomus oscitans* (Boddaert, 1783) +
27. Black Stork, *Ciconia nigra* (Linnaeus, 1758) +
28. White-necked Stork, *Ciconia episcopus* (Boddaert, 1783) +
29. European White Stork, *Ciconia ciconia* (Linnaeus, 1758) +
30. Black-necked Stork, *Ephippiorhynchus asiaticus* (Latham, 1790) +
31. Lesser Adjutant-Stork, *Leptoptilos javanicus* (Horsfield, 1821) +

THRESKIORNITHIDAE : IBISES & SPOONBILLS

32. Glossy Ibis, *Plegadis falcinellus* (Linnaeus, 1766) +
33. Oriental White Ibis, *Threskiornis melanocephalus* (Latham, 1790) +
34. Black Ibis, *Pseudibis papillosa* (Temminck, 1824) +
35. Eurasian Spoonbill, *Platalea leucorodia* Linnaeus, 1758 +

PHOENICOPTERIFORMES**PHOENICOPTERIDAE : FLAMINGOS**

36. Greater Flamingo *Phoenicopterus ruber* Linnaeus, 1758 +
37. Lesser Flamingo *Phoenicopterus minor* (Geoffroy, 1798) +

ANSERIFORMES**ANATIDAE : SWANS, GEESE & DUCKS**

38. Large Whistling-Duck, *Dendrocygna bicolor* (Vieillot, 1816) +
39. Lesser Whistling-Duck, *Dendrocygna javanica* (Horsfield, 1821) +
40. Greylag Goose *Anser anser* (Linnaeus, 1758) +
41. Bar-headed Goose, *Anser indicus* (Latham, 1790) +
42. Brahminy Shelduck, *Tadorna ferruginea* (Pallas, 1764) +
43. Common Shelduck, *Tadorna tadorna* (Linnaeus, 1758) +
44. Comb Duck, *Sarkidiornis melanotos* (Pennant, 1769) +
45. Cotton Teal, *Nettapus coromandelianus* (Gmelin, 1789) +
46. Gadwall, *Anas strepera* Linnaeus, 1758 +
47. Falcated Duck, *Anas falcata* Georgi, 1775 +
48. Eurasian Wigeon *Anas penelope* Linnaeus, 1758 +
49. Mallard, *Anas platyrhynchos* Linnaeus, 1758 +
50. Spot-billed Duck, *Anas poecilorhyncha* J.R. Forester, 1781 +
51. Northern Shoveller, *Anas clypeata* Linnaeus, 1758 +

- 52. Northern Pintail, *Anas acuta* Linnaeus, 1758 +
- 53. Garganey, *Anas querquedula* Linnaeus, 1758 +
- 54. Baikal Teal, *Anas formosa* Georgi, 1775 +
- 55. Common Teal, *Anas crecca* Linnaeus, 1758 +
- 56. Marbled Teal, *Marmaronetta angustirostris* (Ménétriès, 1832) *
- 57. Red-crested Pochard, *Rhodonessa rufina* (Pallas, 1773) +
- 58. Common Pochard, *Aythya ferina* (Linnaeus, 1758) +
- 59. Ferruginous Pochard *Aythya nyroca* (Guldenstadt, 1770) +
- 60. Tufted Pochard, *Aythya fuligula* (Linnaeus, 1758) +
- 61. Greater Scaup, *Aythya marila* (Linnaeus, 1761) +

GRUIFORMES

GRUIDAE : CRANES

- 62. Sarus Crane, *Grus antigone* (Linnaeus, 1758) +
- 63. Demoiselle Crane, *Grus virgo* (Linnaeus, 1758) +
- 64. Common Crane, *Grus grus* (Linnaeus, 1758) +
- 65. Black-necked Crane, *Grus nigricollis* Przevalski, 1876 *

RALLIDAE : RAILS, CRAKES, MOORHENS & COOTS

- 66. Blue-breasted Rail, *Gallirallus striatus* Linnaeus, 1766 +
- 67. Slaty-legged Crake *Rallina eurizonoides* (Lafresnaye, 1845) -
- 68. Water Rail, *Rallus aquaticus* Linnaeus, 1758 +
- 69. Brown Crake, *Amaurornis akool* (Sykes, 1832) +
- 70. White-breasted Waterhen, *Amaurornis phoenicurus* (Pennant, 1769) +
- 71. Spotted Crake, *Porzana porzana* (Linnaeus, 1766) +
- 72. Ruddy-breasted Crake, *Porzana fusca* (Linnaeus, 1766) +
- 73. Watercock, *Gallicrex cinerea* (Gmelin, 1789) +
- 74. Purple Moorhen, *Porphyrio porphyrio* (Linnaeus, 1758) +
- 75. Common Moorhen, *Gallinula chloropus* (Linnaeus, 1758) +
- 76. Common Coot, *Fulica atra* Linnaeus, 1758 +

OTIDIDAE : BUSTARDS

- 77. Lesser Florican, *Sypheotides indica* (J.F. Miller, 1782) -

CHARADRIIFORMES

JACANIDAE : JACANAS

- 78. Pheasant-tailed Jacana, *Hydrophasianus chirurgus* (Scopoli, 1786) +

79. Bronze-winged Jacana, *Metopidius indicus* (Latham, 1790) +

ROSTRATULIDAE : PAINTED-SNIPES

80. Greater Painted-Snipe, *Rostratula benghalensis* (Linnaeus, 1758) +

HAEMATOPODIDAE : OYSTERCATCHER

81. Eurasian Oystercatcher, *Haematopus ostralegus* Linnaeus, 1758 *

CHARADRIIDAE : PLOVERS, DOTTERELS & LAPWINGS

82. European Golden Plover, *Pluvialis apricaria* (Linnaeus, 1758) +

83. Grey Plover, *Pluvialis squatarola* (Linnaeus, 1758) +

84. Common Ringed Plover, *Charadrius hiaticula* Linnaeus, 1758 +

85. Little Ringed Plover, *Charadrius dubius* Scopoli, 1786 +

86. Kentish Plover *Charadrius alexandrinus* Linnaeus, 1758 +

87. Lesser Sand Plover, *Charadrius mongolus* Pallas, 1776 +

88. Greater Sand Plover, *Charadrius leschenaultii* Lesson, 1826 +

89. Yellow-wattled Lapwing, *Vanellus malabaricus* (Boddaert, 1783) +

90. Red-wattled Lapwing, *Vanellus indicus* (Boddaert, 1783) +

91. White-tailed Lapwing, *Vanellus leucurus* (Lichtenstein, 1823) +

SCOLOPACIDAE : SANDPIPERS, STINTS, SNIPES, GODWITS & CURLEWS

92. Eurasian Woodcock, *Scolopax rusticola* Linnaeus, 1758+

93. Wood Snipe, *Gallinago nemoricola* Hodgson, 1836 *

94. Pintail Snipe, *Gallinago stenura* (Bonaparte, 1830) *

95. Common Snipe, *Gallinago gallinago* (Linnaeus, 1758)+

96. Jack Snipe, *Lymnocyptes minimus* (Brünnich, 1764)+

97. Black-tailed Godwit, *Limosa limosa* (Linnaeus, 1758)+

98. Bar-tailed Godwit, *Limosa lapponica* (Linnaeus, 1758)+

99. Whimbrel, *Numenius phaeopus* (Linnaeus, 1758)*

100. Eurasian Curlew, *Numenius arquata* (Linnaeus, 1758)+

101. Spotted Redshank, *Tringa erythropus* (Pallas, 1764)*

102. Common Redshank, *Tringa totanus* (Linnaeus, 1758)+

103. Marsh Sandpiper, *Tringa stagnatilis* (Bechstein, 1803)+

104. Common Greenshank, *Tringa nebularia* (Gunner, 1767)+

105. Spotted Greenshank, *Tringa guttifer* (Nordmann, 1835)*

106. Green Sandpiper, *Tringa ochropus* Linnaeus, 1758+

107. Wood Sandpiper, *Tringa glareola* Linnaeus, 1758+

- 108. Terek Sandpiper, *Xenus cinereus* (Guldenstadt, 1774)+
- 109. Common Sandpiper, *Actitis hypoleucos* Linnaeus, 1758+
- 110. Ruddy Turnstone, *Arenaria interpres* (Linnaeus, 1758)
- 111. Red Knot, *Calidris canutus* (Linnaeus, 1758)+
- 112. Sanderling, *Calidris alba* (Pallas, 1764)+
- 113. Little Stint *Calidris minuta* (Leisler, 1812)+
- 114. Temminck's Stint, *Calidris temminckii* (Leisler, 1812)+
- 115. Dunlin, *Calidris alpina* (Linnaeus, 1758)+
- 116. Curlew Sandpiper, *Calidris ferruginea* (Pontoppidan, 1813)*
- 117. Ruff, *Philomachus pugnax* (Linnaeus, 1758)+

RECURVIROSTRIDAE : IBISBILL, AVOCETS & STILTS

- 118. Black-winged Stilt, *Himantopus himantopus* (Linnaeus, 1758)+
- 119. Pied Avocet, *Recurvirostra avosetta* Linnaeus, 1758+

PHALAROPODIDAE : PHALAROPES

- 120. Red Phalarope, *Phalaropus fulicaria* (Linnaeus, 1758)*

DROMADIDAE : CRAB-PLOVERS

- 121. Crab-Plover, *Dromas ardeola* Paykull, 1805*

BURHINIDAE : STONE PLOVERS/THICK-KNEES

- 122. Stone-Curlew, *Burhinus oedicephalus* (Linnaeus, 1758) -
- 123. Great Stone-Plover, *Esacus recurvirostris* (Cuvier, 1829)+

GLAREOLIDAE : PRATINCOLES

- 124. Cream-coloured Courser, *Cursorius cursor* (Latham, 1787) -
- 125. Collared Pratincole, *Glareola pratincola* (Linnaeus, 1766)+
- 126. Small Pratincole, *Glareola lactea* Temminck, 1820+

LARIDAE : GULLS, TERNS & NODDIES

- 127. Brown-headed Gull, *Larus brunnicephalus* Jerdon, 1840+
- 128. Black-headed Gull, *Larus ridibundus* Linnaeus, 1766+
- 129. Little Gull, *Larus minutus* Pallas, 1776*
- 130. Gull-billed Tern, *Gelochelidon nilotica* (Gmelin, 1789)+
- 131. Caspian Tern, *Sterna caspia* Pallas, 1770+
- 132. River Tern, *Sterna aurantia* J.E. Gray, 1831+
- 133. Common Tern, *Sterna hirundo* Linnaeus, 1758+
- 134. Little Tern, *Sterna albifrons* Pallas, 1764+

135. Black-bellied Tern, *Sterna acuticauda* J.E. Gray, '1831'
 136. Whiskered Tern, *Chlidonias hybridus* (Pallas, 1811)+
 137. White-winged Black Tern, *Chlidonias leucopterus* (Temminck, 1815)+

RYNCHOPIDAE : SKIMMERS

138. Indian Skimmer, *Rynchops albicollis* Swainson, 1838*

WETLAND DEPENDENT AND ASSOCIATED BIRDS

FALCONIFORMES

ACCIPITRIDAE : EAGLES, KITES & HARRIERS

139. Brahminy Kite, *Haliastur indus* (Boddaert, 1783)+
 140. Pallas's Fish-Eagle, *Haliaeetus leucoryphus* (Pallas, 1771)*
 141. Western Marsh-Harrier, *Circus aeruginosus* (Linnaeus, 1758)+
 142. Greater Spotted Eagle, *Aquila clanga* Pallas, 1811'

CORACIIFORMES

ALCEDINIDAE : KINGFISHERS

143. Blyth's Kingfisher, *Alcedo hercules* Laubmann, 1917*
 144. Small Blue Kingfisher, *Alcedo atthis* (Linnaeus, 1758)+
 145. White-breasted Kingfisher, *Halcyon smyrnensis* (Linnaeus, 1758)+
 146. Lesser Pied Kingfisher, *Ceryle rudis* (Linnaeus, 1758)+

Nalsarovar fall in the migratory route, thousands of birds stop over before spreading out to rest of Gujarat. Migratory birds start arriving in the month of October and population reaches its peak in January. Birds leave the area when it dries up in the month of March-April. Population of pelican, ducks and geese reaches over 2500 and 46000 respectively during winter. Waders' population reaches to peak when water depth decreases in the last week of January. Water birds belonging to groups of grebe, pelican, ducks and geese, rail, coot, cormorant, heron, egret, bittern, stork, ibis and spoonbill, flamingo, crane, wader, gull, tern, kingfisher, jacana have been recorded in the sanctuary. Probability of 45 birds breeding at Nal has been documented (GEER, 1998).

In the present study species diversity was recorded from all the available habitats in and around Nalsarovar wetland during the period from 1999-2003. Breeding of nine species viz. Little Grebe, Little Cormorant, Little Egret, Painted Stork, Eurasian Spoon Bill, Glossy Ibis, Sarus Crane, Purple Moorhen and Pheasant-tailed Jacana were recorded in Nalsarovar. Though population count was also made to record the population of different species in this vast expanse of Nalsarovar, it is difficult and may be inconsistent to work out any dynamics in this regard based on uneven attempt by an individual. Therefore only species diversity has been documented. However, the population of wetland birds especially ducks and waders were found to be very large in number may be beyond imagination of a bird watcher. For

example, the population of Brahminy duck was recorded in thousands. The congregation of waders was also of the same proportion. Congregating population of Demoiselle crane and Common crane on the dried margins and along the cultivated fields of the Nalsarovar were also very large in number especially in the high elevated portion of Nal popularly known as *Nal Ka Hal* (Plate 5 & 6).

The habitat preference, residential status, migratory breeding and probability of breeding of wetland avifauna are given in Table 11.

Table 11. Habitat Preference and Status of Wetland Avifauna, Nalsarovar

Wetland Birds	Habitat	Status
PODICIPEDIDAE		
<i>Tachybaptus ruficollis</i> (Pallas, 1764)	B, lm,r, ow	C, Re,
<i>Podiceps cristatus</i> (Linnaeus, 1758)	M,ow	O, wm
<i>Podiceps nigricollis</i> Brehm, 1831	M, ow	R, wm
PELECANIDAE		
<i>Pelecanus onocrotalus</i> Linnaeus, 1758	M, lm, r, odw	C
<i>Pelecanus philippensis</i> Gmelin, 1789	M, lm, r, odw	R
<i>Pelecanus crispus</i> Bruch, 1832	M, lm, r ,odw	UC
PHALACROCORACIDAE		
<i>Phalacrocorax niger</i> (Vieillot, 1817)	B, lm, r, odw, osw	C
<i>Phalacrocorax fuscicollis</i> Stephens, 1826	Lm, r, odw, osw	O
<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	P, lm, r, odw, osw, eav	C
ANHINGIDAE		
<i>Anhinga melanogaster</i> Pennant, 1769	Lm, odw, osw	UC
ARDEIDAE		
<i>Egretta garzetta</i> (Linnaeus, 1766)	B, r, eav	C
<i>Egretta gularis</i> (Bosc, 1792)	P, lm, r, osw, eav, ma, sl	UC
<i>Ardea cinerea</i> Linnaeus, 1758	P, lm, r, ma	C
<i>Ardea purpurea</i> Linnaeus, 1766	Lm, r, eav	C
<i>Casmerodius albus</i> (Linnaeus, 1758)	P, lm, r, osw	C
<i>Mesophoyx intermedia</i> (Wagler, 1829)	P, lm, r, osw	C
<i>Bubulcus ibis</i> (Linnaeus, 1758)	P, r, sl, cl, fl, wa	C
<i>Ardeola grayii</i> (Sykes, 1832)	P, r, ma	C
<i>Butorides striatus</i> (Linnaeus, 1758)	P, lm, r, eav	UC
<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	P, lm, r, eav, ma, sl, cl, fl	C

Table 11. Contd.

Wetland Birds	Habitat	Status
<i>Ixobrychus minutus</i> (Linnaeus, 1766)	M, eav, ma	UC
<i>Ixobrychus sinensis</i> (Gmelin, 1789)	Lm, r, eav, ma	R
<i>Ixobrychus cinnamomeus</i> (Gmelin, 1789)	Lm, r, eav, ma	O
<i>Botaurus stellaris</i> (Linnaeus, 1758)	M, eav	R
CICONIIDAE		
<i>Mycteria leucocephala</i> (Pennant, 1769)	B, lm, r, osw, eav	C
<i>Anastomus oscitans</i> (Boddaert, 1783)	B, lm, r, osw	C
<i>Ciconia nigra</i> (Linnaeus, 1758)	M, osw	R
<i>Ciconia episcopus</i> (Boddaert, 1783)	Lm, r, osw	O
<i>Ciconia ciconia</i> (Linnaeus, 1758)	M, osw	UC
<i>Ephippiorhynchus asiaticus</i> (Latham, 1790)	Lm, r, m, osw	R
<i>Leptoptilos javanicus</i> (Horsfield, 1821)	Lm, osw	R
THRESKIORNITHIDAE		
<i>Plegadis falcinellus</i> (Linnaeus, 1766)	B, lm, r, ma, wa	C
<i>Threskiornis melanocephalus</i> (Latham, 1790)	P, lm, r, ma, wa	C
<i>Pseudibis papillosa</i> (Temminck, 1824)	P, lm, r, sl, wa	C
<i>Platalea leucorodia</i> Linnaeus, 1758	P, lm, m, osw	C
PHOENICOPTERIDAE		
<i>Phoenicopterus ruber</i> Linnaeus, 1758	Lm, m, osw	C
<i>Phoenicopterus minor</i> (Geoffroy, 1798)	Lm, m, osw	C
ANATIDAE		
<i>Dendrocygna bicolor</i> (Vieillot, 1816)	R, l, m, osw	R
<i>Dendrocygna javanica</i> (Horsfield, 1821)	R, lm, osw	UC
<i>Anser anser</i> (Linnaeus, 1758)	M, cl, fl	UC
<i>Anser indicus</i> (Latham, 1790)	Lm, r, m, cl, fl	O
<i>Tadorna ferruginea</i> (Pallas, 1764)	Lm, r, m, osw	C
<i>Tadorna tadorna</i> (Linnaeus, 1758)	M, eaw	R
<i>Sarkidiornis melanotos</i> (Pennant, 1769)	P, lm, r, osw	C
<i>Nettapus coromandelianus</i> (Gmelin, 1789)	R, lm, osw	C
<i>Anas strepera</i> Linnaeus, 1758	M, osw	C
<i>Anas falcata</i> Georgi, 1775	M, odw, osw, eav	R

Table 11. Contd.

Wetland Birds	Habitat	Status
<i>Anas penelope</i> Linnaeus, 1758	M, osw	C
<i>Anas platyrhynchos</i> Linnaeus, 1758	M, osw	UC
<i>Anas poecilorhyncha</i> J.R. Forester, 1781	P, lm, r, osw	C
<i>Anas clypeata</i> Linnaeus, 1758	M, osw	C
<i>Anas acuta</i> Linnaeus, 1758	M, osw	C
<i>Anas querquedula</i> Linnaeus, 1758	M, osw	C
<i>Anas formosa</i> Georgi, 1775	M, osw	R
<i>Anas crecca</i> Linnaeus, 1758	M, osw	C
<i>Marmaronetta angustirostris</i> (Ménétrières, 1832)	M, osw	R
<i>Rhodonessa rufina</i> (Pallas, 1773)	M, osw	O
<i>Aythya ferina</i> (Linnaeus, 1758)	M, odw	C
<i>Aythya nyroca</i> (Guldenstadt, 1770)	M, odw	O
<i>Aythya fuligula</i> (Linnaeus, 1758)	M, odw	O
<i>Aythya marila</i> (Linnaeus, 1761)	M, osw	R
GRUIDAE		
<i>Grus antigone</i> (Linnaeus, 1758)	B, r, cl, fl	UC
<i>Grus virgo</i> (Linnaeus, 1758)	M, cl, fl	C
<i>Grus grus</i> (Linnaeus, 1758)	M, cl, fl	C
<i>Grus nigricollis</i> Przevalski, 1876	M, ma, sl, cl, fl	C
RALLIDAE		
<i>Gallirallus striatus</i> Linnaeus, 1766	R, ma, sl	O
<i>Rallus aquaticus</i> Linnaeus, 1758	R, ma, sl	O
<i>Amaurornis akool</i> (Sykes, 1832)	P, r, l, m, eaq	UC
<i>Amaurornis phoenicurus</i> (Pennant, 1769)	P, r, l, m, ma	C
<i>Porzana porzana</i> (Linnaeus, 1766)	M, eaq	R
<i>Porzana fusca</i> (Linnaeus, 1766)	R, eaq	R
<i>Gallicrex cinerea</i> (Gmelin, 1789)	P, r, lm, eav	O
<i>Porphyrio porphyrio</i> (Linnaeus, 1758)	B, r, eav	O
<i>Gallinula chloropus</i> (Linnaeus, 1758)	P, r, eav, sl, cl	C
<i>Fulica atra</i> Linnaeus, 1758	R, lm, m, odw	C

Table 11. Contd.

Wetland Birds	Habitat	Status
JACANIDAE		
<i>Hydrophasianus chirurgus</i> (Scopoli, 1786)	B, r, l, m, eav	C
<i>Metopidius indicus</i> (Latham, 1790)	P, r, lm, eav	UC
ROSTRATULIDAE		
<i>Rostratula benghalensis</i> (Linnaeus, 1758)	M, eav, sl	UC
HAEMATOPODIDAE		
<i>Haematopus ostralegus</i> Linnaeus, 1758	M, ma	R
CHARADRIIDAE		
<i>Pluvialis apricaria</i> (Linnaeus, 1758)	M, ma	R
<i>Pluvialis squatarola</i> (Linnaeus, 1758)	M, ma	O
<i>Charadrius hiaticula</i> Linnaeus, 1758	R, lm, sl	C
<i>Charadrius dubius</i> Scopoli, 1786	R, lm, sl	C
<i>Charadrius alexandrinus</i> Linnaeus, 1758	P, lm, r, ma	C
<i>Charadrius mongolus</i> Pallas, 1776	M, ma	UC
<i>Charadrius leschenaultii</i> Lesson, 1826	M, ma	O
<i>Vanellus malabaricus</i> (Boddaert, 1783)	P, lm, r, sl	UC
<i>Vanellus indicus</i> (Boddaert, 1783)	P, r, sl	C
<i>Vanellus leucurus</i> (Lichtenstein, 1823)	M, sl	C
SCOLOPACIDAE		
<i>Scolopax rusticola</i> Linnaeus, 1758	eav, ma, sl	O
<i>Gallinago nemoricola</i> Hodgson, 1836	eav, ma, sl	R
<i>Gallinago stenura</i> (Bonaparte, 1830)	eav, ma, sl	C
<i>Gallinago gallinago</i> (Linnaeus, 1758)	Lm, m, ma	C
<i>Lymnocyptes minimus</i> (Brünnich, 1764)	M, ma	O
<i>Limosa limosa</i> (Linnaeus, 1758)	M, ma	C
<i>Limosa lapponica</i> (Linnaeus, 1758)	M, ma	UC
<i>Numenius phaeopus</i> (Linnaeus, 1758)	M, ma, sl	UC
<i>Numenius arquata</i> (Linnaeus, 1758)	M, ma	C
<i>Tringa erythropus</i> (Pallas, 1764)	M, ma	C
<i>Tringa totanus</i> (Linnaeus, 1758)	M, ma	C
<i>Tringa stagnatilis</i> (Bechstein, 1803)	M, ma	C

Table 11. *Contd.*

Wetland Birds	Habitat	Status
<i>Tringa nebularia</i> (Gunner, 1767)	M, ma	C
<i>Tringa guttifer</i> (Nordmann, 1835)	M, ma	UC
<i>Tringa ochropus</i> Linnaeus, 1758	M, ma	C
<i>Tringa glareola</i> Linnaeus, 1758	M, ma	UC
<i>Xenus cinereus</i> (Guldenstadt, 1774)	M, ma	UC
<i>Actitis hypoleucos</i> Linnaeus, 1758	M, ma	C
<i>Calidris canutus</i> (Linnaeus, 1758)	M, ma	R
<i>Calidris alba</i> (Pallas, 1764)	M, ma	R
<i>Calidris minuta</i> (Leisler, 1812)	M, ma	C
<i>Calidris temminckii</i> (Leisler, 1812)	M, ma	C
<i>Calidris alpina</i> (Linnaeus, 1758)	M, ma	R
<i>Calidris ferruginea</i> (Pontoppidan, 1813)	M, ma	R
<i>Philomachus pugnax</i> (Linnaeus, 1758)	M, ma	C
RECURVIROSTRIDAE		
<i>Himantopus himantopus</i> (Linnaeus, 1758)	P, r, ma	C
<i>Recurvirostra avosetta</i> Linnaeus, 1758	P, rl, m, ma	C
PHALAROPODIDAE		
<i>Phalaropus fulicaria</i> (Linnaeus, 1758)	eav, sl	UC
DROMADIDAE		
<i>Dromas ardeola</i> Paykull, 1805	sl	UC
BURHINIDAE		
<i>Esacus recurvirostris</i> (Cuvier, 1829)	M, ma	UC
GLAREOLIDAE		
<i>Glareola pratincola</i> (Linnaeus, 1766)	sl, fl	UC
<i>Glareola lactea</i> Temminck, 1820	sl, fl	R
LARIDAE		
<i>Larus brunnicephalus</i> Jerdon, 1840	M, odw, osw	UC
<i>Larus ridibundus</i> Linnaeus, 1766	M, odw, osw	C
<i>Larus minutus</i> Pallas, 1776	M, odw, osw	R
<i>Gelochelidon nilotica</i> (Gmelin, 1789)	M, odw, osw	C
<i>Sterna caspia</i> Pallas, 1770	R, lm, odw, osw	O

Table 11. Contd.

Wetland Birds	Habitat	Status
<i>Sterna aurantia</i> J.E. Gray, 1831	P, r, lm, odw, osw	C
<i>Sterna hirundo</i> Linnaeus, 1758	P, lm, r, odw, osw	R
<i>Sterna albifrons</i> Pallas, 1764	P, lm, r, odw, osw	UC
<i>Chlidonias hybridus</i> (Pallas, 1811)	R, lm, odw, osw	UC
<i>Chlidonias leucopterus</i> (Temminck, 1815)	R, lm, odw, osw	R
RYNCHOPIDAE		
<i>Rynchops albicollis</i> Swainson, 1838	sl, bets	R

C = Common; UC = Uncommon; O = Occasional; R = Rare; odw = Open deep water; osw = open shallow water; eav = emergent aquatic vegetation; ma = muddy area; sl = shore land; cl = crop land; fl = fallow land; wa = woody area; r = resident species; M = migratory species; lm = local migratory species; P = potential breeding; B = breeding.

Seventeen species are in the status of vulnerable, Threatened, Near Threatened belonging to 10 families of aves. The conservation status of important avian species is given in Table 12.

Table 12. Status of Important Avian Species at Nalsarovar Bird Sanctuary.

Family	Species Name	Conservation Status (Iucn)
ECANIDAE	<i>Pelecanus crispus</i> Bruch, 1832	Threatened, Conservation dependant
ANHINGIDAE	<i>Anhinga melanogaster</i> Pennant, 1769	Near Threatened
CICONIIDAE	<i>Mycteria leucocephala</i> (Pennant, 1769) <i>Ephippiorhynchus asiaticus</i> (Latham, 1790)	Near Threatened Near Threatened
THRESKIORNITHIDAE	<i>Threskiornis melanocephalus</i> (Latham, 1790)	Near Threatened
PHOENICOPTERIDAE	<i>Phoenicopterus minor</i> (Geoffroy, 1798)	Near Threatened
ANATIDAE	<i>Aythya nyroca</i> (Guldenstadt, 1770)	Near Threatened
GRUIDAE	<i>Grus antigone</i> (Linnaeus, 1758)	Vulnerable
RYNCHOPIDAE	<i>Rynchops albicollis</i>	Vulnerable
ACCIPITRIDAE	<i>Haliaeetus leucoryphus</i> <i>Gyps bengalensis</i> (Gmelin, 1788)*	Threatened Critically Endangered

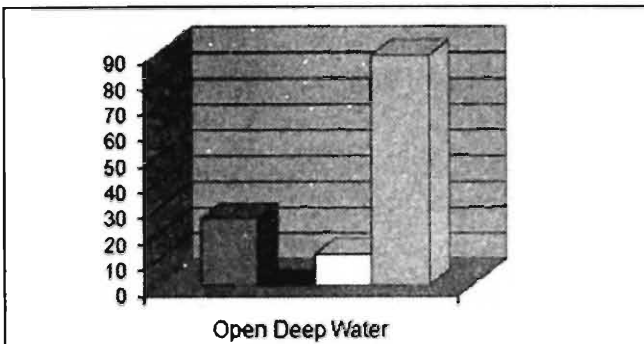


Fig. 11 : Habitat Preference of Wetland Birds at Nalsarovar : Open Deep Water

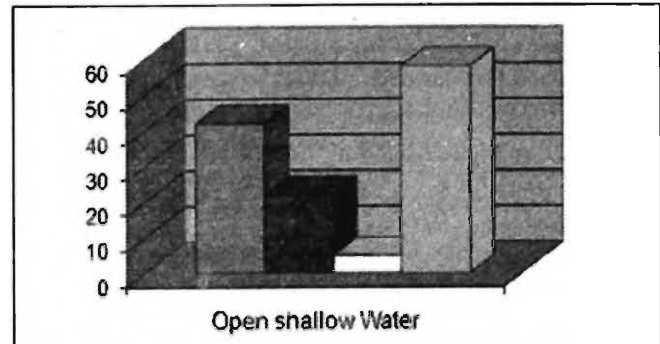


Fig. 12 : Habitat Preference of Wetland Birds at Nalsarovar : Open Shallow Water

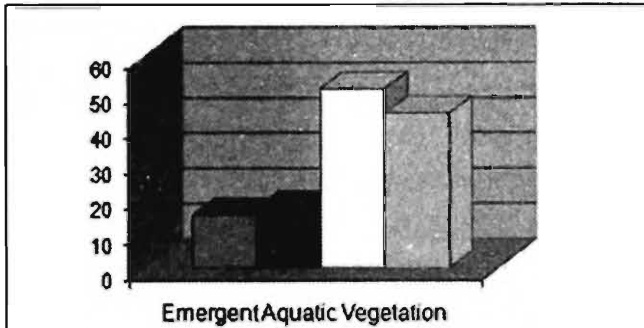


Fig. 13 : Habitat Preference of Wetland Birds at Nalsarovar : Emergent Aquatic Vegetation

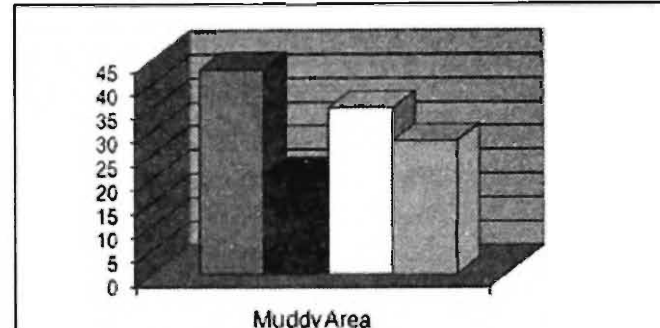


Fig. 14 : Habitat Preference of Wetland Birds at Nalsarovar : Muddy Area

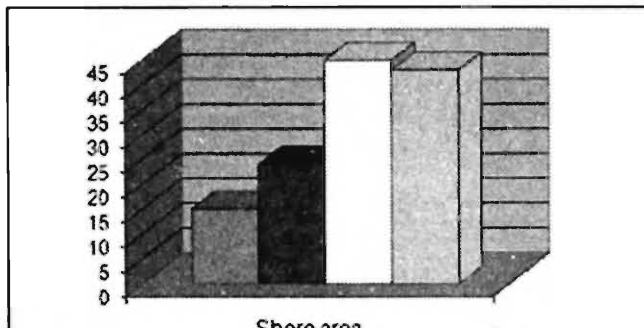


Fig. 15 : Habitat Preference of Wetland Birds at Nalsarovar : Shore Area

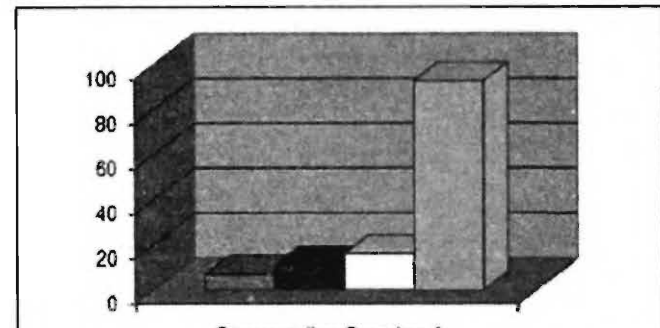


Fig. 16 : Habitat Preference of Wetland Birds at Nalsarovar : Surrounding Crop Land

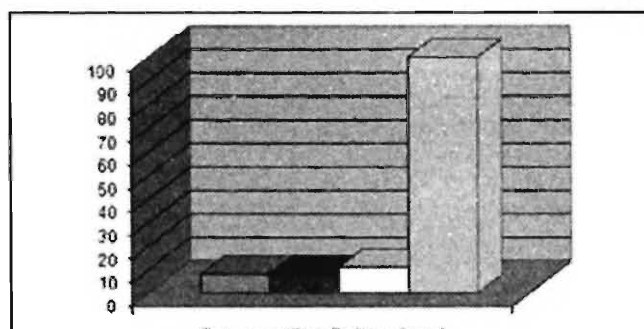


Fig. 17 : Habitat Preference of Wetland Birds at Nalsarovar : Surrounding Fallow Land

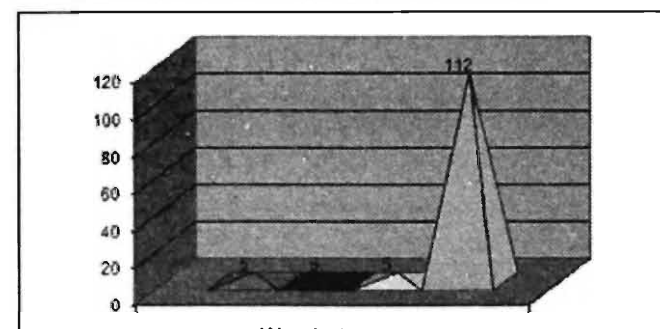


Fig. 18 : Habitat Preference of Wetland Birds at Nalsarovar : Wooded Areas

■ Maximum preference ■ Medium preference □ Some preference □ Least preferred

Table 12. Contd.

Family	Species Name	Conservation Status (Iucn)
	<i>Gyps indicus</i> (Scopoli, 1786)*	Critically Endangered
	<i>Aquila heliaca</i> Savigny, 1809*	Vulnerable
	<i>Aquila clanga</i> Pallas, 1811	Vulnerable
	<i>Sarcogyps calvus</i> (Scopoli, 1786)	Near Threatened
	<i>Aegypius monachus</i> (Linnaeus, 1766)	Near Threatened
FALCONIDAE	<i>Falco naumanni</i> Fleischer, 1818*	Vulnerable

* Globally Threatened.

The large data collected on population count of abundant species of birds is still to be analyzed using some suitable population indices so as to project correct taxa based data and conservation strategies for the lake ecosystem. The habitat preference of wetland birds is shown in Fig.11 to Fig. 18.

Poaching and trapping of birds at Nalsarovar is a very common practice. Due to congregation of very high population of most avian species and lack of legal framework to control such activity, the ecosystem is facing severe setback and may be if not taken care the population may dwindle in future.

6.2.5. Mammalia

Mammalian fauna associated with Nalsarovar wetland has been worked out by GEER Foundation (1998), Singh (2001) and Islam and Rahamani, (2004). The present account enlists twenty-five mammalian species inhabiting mainly dry land areas from the Nalsarovar Wetland, Gujarat. The species were mainly observed during 1999-2003 while undertaking the faunal survey of the wetland (Appendix 6). The classification and conservation status is followed after Ellerman and Morrison-Scott (1951), Honaki *et al.* (1982), Alfred, *et al.* (2002) and Alfred, *et al.* (2006). Abbreviations used in the text: Lrnt = Lower Risk Near Threatened; LRlc = Lower Risk Least Concern; VU = Vulnerable, EN = Endangered; CR = Critically Endangered; DD = Data Deficient; IWPA = Indian Wildlife (Protection) Act, 1972; CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora; CAMP = Conservation Assessment and Management Plan of Biodiversity Conservation Prioritization Project; IUCN = International Union for Conservation of Nature and Natural Resources. Species marked with + reported earlier, with * reported in the present study. Ten species are new records from the area.

SYSTEMATIC ACCOUNT

Order INSECTIVORA

Family SORICIDAE

Subfamily CROCIDURINAE

Genus *Suncus* Ehrenberg, 1832

1. *Suncus murinus* (Linnaeus, 1766)

House Shrew

1766. *Sorex murinus* Linnaeus, *Syst. Nat.* 12th ed. 1 : 74, Type locality: Java, Indonesia

Species Observed : 1 ex., 15.ii.2000, Pan Bet near Hinglaja Mata Mandir at light Trap; 1 ex., 19.x.2001, Ranagadh W. T.; 1 ex., 1.iv.2003, Nani Kathechi area, recorded by S. Kumar.

Diagnostic characters : Greyish dark brown, emits strong musk odour, make squeaking sound, nocturnal in habit.

Distribution : India : Throughout the country.

Elsewhere : S. E. Asia, Continental & peninsular Indo-malayan region, Coastal Africa, Madagascar, Comores, Mauritius and into coastal Arabia.

Remarks : The species was found within the old abandoned building at the Bet.

Status : CAMP : LR1c (Nationally); DD (Globally).

2. **Suncus etruscus* (Savi, 1822)

Pygmy White-toothed Shrew**

1822. *Sorex etruscus* Savi, *Nuovo Giorn. de Letterati, Pisa*, 1 : 60.

Species Observed : 1 ex., Dharabla Bet, Nalsarovar wetland, 11.xii.2000, Reg. No.: 289/6, coll. Sanjeev Kumar.

Diagnostic characters : Velvety dark greyish brown above, silvery brown below; ears pink; head and body length 3-5.5 cm, tail 2.5-3.5 cm. Nocturnal, terrestrial and semifossorial in habit.

Distribution : India : Throughout.

Elsewhere : Afghanistan, Arabian Peninsula, Asia Minor, Bhutan, China, Iraq, Malaysia, Nepal, North Africa, Pakistan, South Europe, Sri Lanka, Thailand, Ethiopia, Guinea and Nigeria. Occurrence in the last three States requires confirmation.

Remarks : Smallest mammal of the world.

Status : CAMP : LR1c (Nationally and Globally).

Order CHIROPTERA

Suborder MEGACHIROPTERA

Family PTEROPODIDAE

Subfamily PTEROPODINAE

Genus *Cynopterus* Cuvier, 1824

3. *Cynopterus sphinx* (Vahl, 1797)

Short-nosed Fruit Bat

1797. *Vespertilio sphinx* Vahl, *Skr. Nat. Selsk, Copenhagen*, 4(1) : 123. *Type locality* : Travancore, Kerala, India.

Species Observed : 1 ex., Bagodra side, Nalsarovar, 29.iii.1999, Reg. No. : 11063/5. coll. Sanjeev Kumar.

Diagnostic characters : Medium in size, ears large, brownish in colour, roosts in groups.

Distribution : India: Throughout.

Elsewhere : Bangladesh, Bhutan, Campuchia, China, Indonesia, Malaysia, Myanmar, Pakistan, Sri Lanka, Thailand, Vietnam and many south east Asian Islands.

Remarks : Congregation of bats was sighted in the unattended buildings at the Forest GH Nalsarovar.

Status : CAMP: LR1c (Nationally); DD (Globally).

Family VESPERTILIONIDAE

Genus *Pipistrellus* Kaup, 1829

4. *Pipistrellus ceylonicus* (Kelaart, 1852)

E. Kelaart's Pipistrelle

1852. *Scotophilus ceylonicus* Kelaart, *Prodr. Faun. Zeylanica*, p. 22.

Species Observed : 1 ex., Bagodra side, 29.iii.1999, Reg. No.: 11063/5; 1 ex., Forest Guest House area, 18.xii.2000. Reg. No.:793/6; 1 ex., 6.xii.2000, Reg. No.: 803/6, coll. Sanjeev Kumar, all from Nalsarovar, Gujarat.

Diagnostic characters : Dorsal colour grey brown to chestnut, reddish or golden brown.

Distribution : India : Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal.

Elsewhere : China, Indonesia, Myanmar, Pakistan, Sri Lanka, Thailand.

Remarks : Roosts found in groups and singly.

Status : CAMP: LR1c (Nationally); DD (Globally).

Order PRIMATES
 Family CERCOPITHECIDAE
 Subfamily COLOBINAE
 Genus *Semnopithecus* Desmarest, 1822
 5. *Semnopithecus entellus* (Dufresne, 1797)
Hanuman Langur

1797. *Simia entellus* Dufresne, *Bull. Soc. Philom Paris, ser. 1* : 7: 49 (W. Bengal).

Species Observed : 2 exs., 14.ii.2000, Forest GH Nalsarovar wetland, recorded by S. Kumar. The moving troop consisting of about 17-20 individuals both male, female and juveniles were observed and next day only two were left in the building area of the Forest Guest House.

Diagnostic characters : Black face monkey with long limbs and tail, diurnal, terrestrial and arboreal.

Distribution : India: Throughout the country except NE India and Western part of Gujarat, Uttar Pradesh, West Bengal.

Elsewhere : China, Nepal, Pakistan, Bangladesh and Sri Lanka.

Remarks : This species have been recorded for the first time from this place though this might be there regular migration route of the troops.

Status : IWPA : Schedule II; CAMP : LR1c (Nationally); DD (Globally); CITES : Appendix I and IUCN: LRnt.

Order CARNIVORA
 Family CANIDAE
 Genus *Canis* Linnaeus, 1758
 6. *Canis aureus* Linnaeus, 1758
Asiatic Jackal

1758. *Canis aureus* Linnaeus. *Syst., Nat.*, 10th ed., 1 : 40.

Species Observed : Dharabla Bet, Ranagadh, Mulbavala, Parali, Shiyal and near the margins of lake in almost any where in the vicinity especially sighted inside the lake bed wherever the land dried off.

Diagnostic characters : Smaller than wolf, without elevated forehead and arching brows; coat colour variable with mixture of black and white, buff around the shoulder, ears and legs. Mainly nocturnal in habit.

Distribution : India : Almost throughout the country.

Elsewhere : Afghanistan, central South western and South Asia, North and East Africa, Southeastern Europe, Iran, Nigeria, Tanzania, Thailand, Transcaucasus, Sri Lanka.

Remarks : Often seen across wetland in pair especially at dawn and dusky.

Status : IWPA : Schedule II, Part II; CAMP : LR1c (Nationally); CITES : Appendix III.

7. *Canis lupus* Linnaeus, 1758
Wolf

1758. *Canis lupus* Linnaeus, *Syst. Nat.*, 10th. ed., 1 : 39.

Species observed : 1♂ and 1♀ sighted near Mulbavala in the year 1999 but when approached, moved away briskly in the reed bed of the Nalsarovar.

Diagnostic characters : Larger than Asiatic Jackal and looks like Alsatian dog distinguished by powerful jaws, arching brows and elevated forehead; coat colour variable from sandy fawn to stippled with black. Mainly nocturnal in habit.

Distribution : India : Throughout India except extreme south.

Elsewhere : Throughout the northern hemisphere, North America south to 20° N in Oaxaca (Mexico), Europe, Asia including the Arabian peninsula and Japan excluding Indo-China.

Remarks : It was recorded in the year 1999 when the first survey of the wetland was initiated by the author and later it was sighted five times from 1999-2003 especially when the lake was completely dry in the year 2003. New record from Nalsarovar.

Status : IWPA: Schedule I, Part I; RDB; VU.; CITES: Appendix I.; CAMP: LRnt (Nationally); DD (Globally).

Genus *Vulpes* Frisch, 1775

8. *Vulpes bengalensis* (Shaw, 1800)
Indian Fox

1800. *Canis bengalensis* Shaw, *Gen. Zool. Syst. Nat. Hist.*, 1(2), Mammalia p. 330.

Species Observed : Sighted singly near or on bets which were connected to land.

Diagnostic characters : Slender limped grey coloured species with back of ears grey and tail tip black.

Distribution : India : Throughout.

Elsewhere : Nepal and Pakistan.

Remarks : Commonly seen in and around Nalsarovar wetland.

Status : IUCN : DD; IWPA : Schedule II, Part II; CITES : Appendix III.; CAMP : LRnt (Nationally); DD (Globally).

Family HYAENIDAE

Genus *Hyaena* Brunnich, 1771

9. *Hyaena hyaena* (Linnaeus, 1758)
Striped Hyaena

1771. *Hyaena* Brunnich, *Zool. Fundamenta.*: pp. 34, 42, 43.

Species Observed : Sighted only once in the area between Ranagadh to Mulbavala adjacent to the Nalsarovar wetland.

Diagnostic characters : Dirty grey to cream buff coat with blackish stripes on body and limbs; easily recognized by its broad head, heavy jaws, strong fore-quarter, sloping back to weak hind quarters with heavy crest of hairs all over the neck and back. Tail bushy.

Distribution : India.

Elsewhere : Afganistan, Algeria, CIS countries, Egypt, Ethiopia, Iran, Iraq, Israel, Kenya, Libya, Mali, Morocco, Nepal, Nigeria, Pakistan, Saudia Arabia, Sierra Leone, Somalia, South Africa, Sudan, Tanzania.

Remarks : Very occasionally seen at night.

Status : IUCN: LRnt; IWPA: Schedule III; CAMP: LRnt (Nationally); DD (Globally).

Family FELIDAE

Subfamily FELINAE

Genus *Felis* Linnaeus, 1758

10. *Felis chaus* Schreber, 1777

Jungle Cat

1777. *Felis chaus* Schreber, *Die Säugethiere*, 2(13): pl. 1101B (1777): text, 3(24) : 414.

1832. *Felis kutas* Pearson, *J. Asiat. Soc. Bengl.*, 1: 75 (Medinapur, West Bengal, India).

Species Observed : Frequently seen near the wetland margins in search of food at night and sighted during light trap collection work in Nani Katheki area, Vekriya side, Shahpura, and Ranagadh W. T. area.

Diagnostic characters : Unspotted dorsal coat varying in colour from yellowish grey to tawny rufous; black horizontal stripes present on the inner side of fore legs; tail short with black tip. Mainly nocturnal in habit.

Distribution : India: South of Krishna river in South India, Bihar, Gujarat, Madhya Pradesh, Orissa, Rajasthan, Jammu & Kashmir, Sikkim, Uttar Pradesh and West Bengal.

Elsewhere : Afganistan, Algeria, Arabia, benin, China, Egypt, Iran, Iraq, Israel, Kenya, Malawi, Morocco, Mozambique, Myanmar, Nepal, Pakistan, Sri Lanka, Syria, Thailand, Vietnam, Yemen, Zambia, Zimbabwe and CIS countries.

Remarks : Commonly sighted during the survey work in the night.

Status : IWPA: Schedule II, Part II; CITES: Appendix II; CAMP: LRnt (Nationally); DD (Globally).

Family HERPESTIDAE

Subfamily HERPESTINAE

Genus *Herpestes* Illiger, 1811

11. *Herpestes edwardsii* (E. Geoffrey Saint-Hilaire, 1818)

Indian Grey Mongoose

1818. *Ichneumon edwardsii* E. Geoffroy Saint-Hilaire: *Descrip de L'Egypte*. 2 : 139.

1874. *Herpestes ferrugineus* Blanford, *Proc. zool. Soc. Lond.*, pp. 661 (Larkhana, Sind, Pakistan).

Species Observed : Very good population live in the Forest Guest house backside near the nature trail developed by the forest Deptt. and also in the Ranagadh area of the wetland. Many places in the Parali area near the wetland.

Diagnostic characters : Pale grey grizzled body with reddish brown speckling, face sharply conical with small ears concealed beneath the body, hind foot distinctly reddish.

Distribution : India : Throughout.

Elsewhere : Afganistan, Bahrain, Indonesia, Pakistan, Iran, Japan, Kuwait, Malaysia, Nepal, Saudi Arabia, Sri Lanka.

Remarks : Commonly seen throughout the area especially in the near vicinity of the wetland.

Status : IWPA : Schedule IV; CITES : Appendix III; CAMP : LR1c (Nationally); DD (Globally).

Family VIVERRIDAE

Subfamily PARADOXURINAE

Genus *Paradoxurus* Cuvier, 1821

12. **Paradoxurus hermaphroditus* (Pallas, 1777)

Toddy Cat

1777. *Viverra hermaphroditus* Pallas, In Schreber, *Die Säugethiere*, 3(25) : 426 (1777).

Species Observed : Observed twice in the Nani Katheki area adjacent to wetland in the night searching for food near the temporary settlements of the local fisherman.

Diagnostic characters : Black or blackish brown in colour with coarse hair, under wool whitish, buff or rich yellow, a white patch below the eye. Nocturnal.

Distribution : India : Almost throughout the country except desert part of Rajasthan and Gujarat.

Elsewhere : Bhutan, Combodia, China, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Singapore, Sri Lanka, Thailand, Vietnam, Sulawesi, Moluccas, Aru Islands.

Remarks : Extensively move in the night near the water bodies probably in search of food.

Status : IWPA : Schedule II; Part II; CAMP : LR1c (Nationally); DD (Globally).

Genus *Viverricula* Hodgson, 1838

13. **Viverricula indica* (Desmarest, 1804)

Small Indian Civet

1804. *Viverra indica* Desmarest, *Tabl, Meth. Hist. Nat., In. Nouv. Dict. Hist. Nat.*, 24: 9, 17. Type locality: India.

Species Observed : Sighted during night survey of the mammals in and around Nalsarovar. Mulbavala, Parali, Kaliveji, Shiyal and Durgi are some of the areas where this species was sighted in all most once in each survey.

Diagnostic characters : Smaller than the large Indian Civet, lacking dorsal crest and with tawny grey or grayish brown with black spots, arranged in rows in the flanks. Nocturnal, inhabits grass and under bushes.

Distribution : India: Throughout.

Elsewhere : Bangladesh, Cambodia, China, Hong Kong, Indonesia, Laos, Malaysia, Myanmar, Pakistan, Sri Lanka, Taiwan, Thailand, Vietnam. The species have been introduced in many countries.

Remarks : High intensity light beam when focused on the animal restricts the movement of this species and can be observed very closely in the field.

Status : IWPA : Schedule II, Part II; CITES : Appendix III; CAMP : LRnt (Nationally), DD (Globally).

Order PERISSODACTYLA

Family EQUIDAE

Genus *Equus* Linnaeus, 1758

14. *Equus onager* Boddaert, 1785

Indian Wild Ass

1785. *Equus onager* Boddaert, *Elench. Anim.*, p. 160.

Species Observed : A herd of 8 to 15 wild ass were frequently seen roaming the margins of the Nalsarovar wetland in the winter months during the survey conducted from 1999 to 2003. A population of 110 wild Ass was counted by the author in the year 2001 in a single day count across the Nalsarovar wetland. In the year 2003 when the lake was completely dried the population was as good as in the year 2001.

Diagnostic characters : Slightly larger than domestic Ass. Rufescent grey to fawn or pale chestnut above and white below; mane erect and dark brown and continued as a dark brown stripe along the back to the root of the tail.

Distribution : India : Rann of Kutch (Gujarat).

Elsewhere : Russia, Ukraine, Iraq, Iran, Afganistan, Pakistan, Turkmenia, Uzbekistan.

Remarks : The wild ass frequently migrate from the Little Rann of Kutch to Nalsarovar area in search of food and better habitat (Fig. 19). It was estimated and also observed by the local inhabitants of the villages around Nalsarovar that from 1998 onwards they have become the resident of the Nalsarovar area and their population has also increased.

Status : IUCN : VU; IWPA : Schedule I, Part I, as *E. hemionus khur*; CITES : Appendix I, as *E. hemionus khur*; RDB : EN.

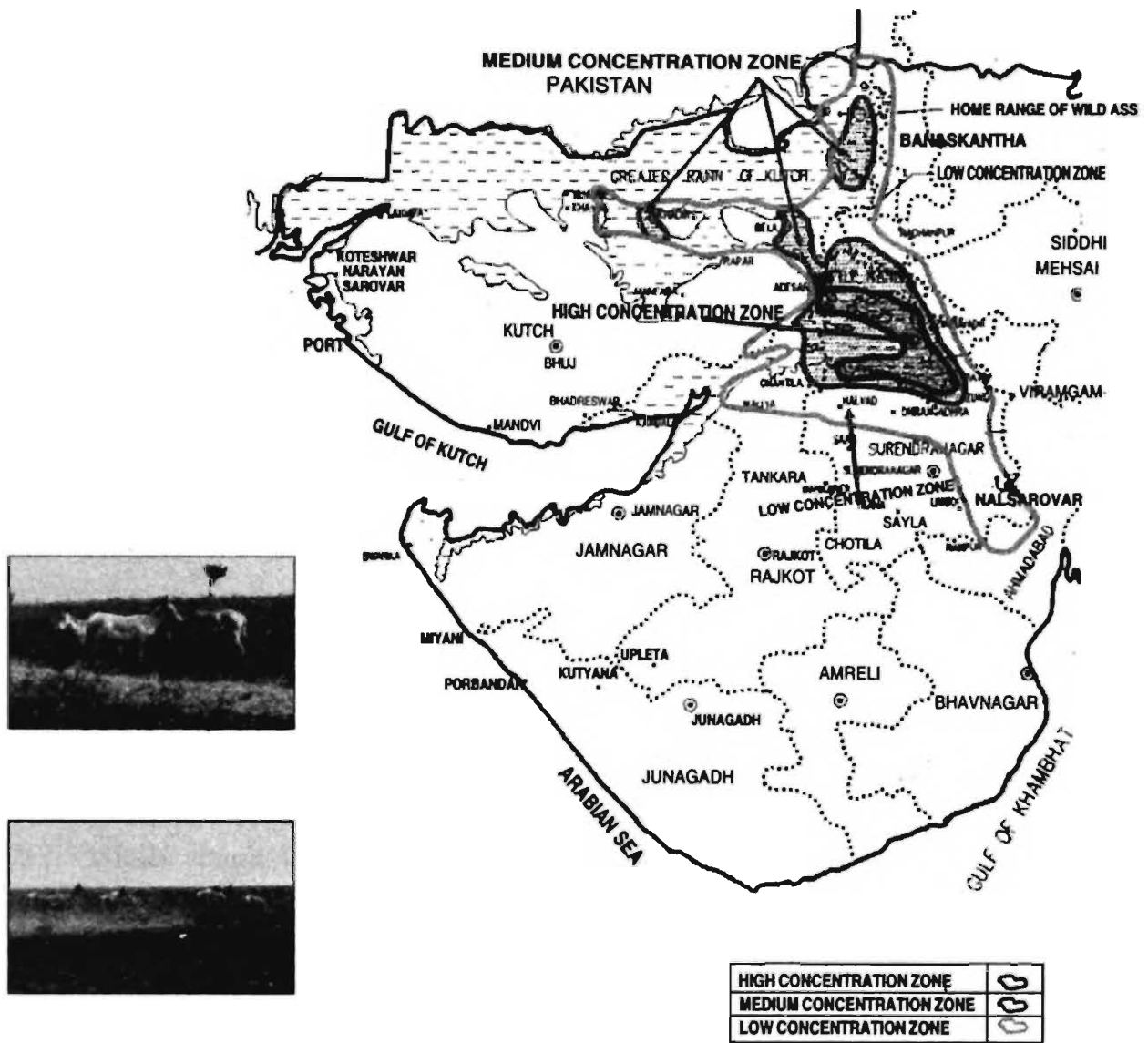


Fig. 19 : Distribution of Wild Ass in its Home Range Showing Different Population Concentration



Indian Wild Ass *Equus onager khur*

Order ARTIODACTYLA

Family SUIDAE

Subfamily SUINAE

Genus *Sus* Linnaeus, 175815. *Sus scrofa* Linnaeus, 1758**Wild Boar**

1758. *Sus scrofa* Linnaeus, *Syst. Nat.* 10th ed., 1 : 49. *Type locality* : Germany.

Species Observed : Hundreds of wild boars through the Nalsarovar wetland. They are generally sighted in the most desolate areas of the Nalsarovar towards Ranagadh to Mulbavala area of the lake. Durgi, Shyial and Meni side of the Nalsarovar wetland also harbours good population of the species and they were frequently sighted during the survey in these areas.

Diagnostic characters : Females smaller than males. Body with short thick neck and slender legs. Head with sloping muzzle, large ears and small eyes. Body colour varies from dark gray to pinkish brown with coarse black and brown bristles. Tusk like canine developed in adult males.

Distribution : Throughout forested or semi-forested tracts of whole of India.

Elsewhere : Australia, China, U.S.A, Central and South America, Europe, Norway, Sweden, South Russia to middle east, Pakistan, South Africa, Sri Lanka, Nepal, Bangladesh, Fiji Islands, Galapagos, Hawain Islands, Myanmar, Indonesia, Lesser Sunde Islands, Solomon Islands, Mauritius, Molucca Islands, Malaysia West Indies and Vietnam.

Remarks : The tall reeds are the most secured hiding places for the large population of the wild boars. Moving groups of the species are like a marching army entering the muddy and shallow zones of the lake with submerged vegetation so that they can feed on the tuberous roots in the Nal. In the night their moving group of hundreds can be spotted by their loud growling sound in the tall reed forest of the Nal.

Status : IWPA : Schedule III; CAMP : LR1c (Nationally); DD (Globally).

Family BOVIDAE

Subfamily ANTILOPINAE

Genus *Antilope* Pallas, 176616. *Antilope cervicapra* (Linnaeus, 1758)**Black Buck**

1758. *Capra cervicapra* Linnaeus, *Syst. Nat.*, 10th ed., 1:69 (Inland of Trivandrum, Kerala, India).

Species Observed : The agriculture land area in the near vicinity of the Nalsarovar wetland has very small population of the blackbuck. They were mostly sighted in the habitat zone near villages on fellow land and also on the agricultural land within the Nalsarovar area.

Diagnostic characters : Female distinct with yellowish fawn coat above and white below and without horns. Male bears spirally twisted long, slender horns with rounded transverse ridges and black dorsally with white underparts. Females reddish dorsally and hornless.

Distribution : India : Punjab, Rajasthan, Gujarat, Bihar, Assam in the east and up to Kanyakumari in south. Elsewhere: Pakistan. Introduced population in Nepal, Texas (U.S.A.) and Argentina.

Remarks : Moderately seen in the region.

Status : IUCN: VU; IWPA: Schedule I; Part I; RDB: VU; CITES: Appendix III; CAMP: LR1c (Nationally); DD (Globally).

Subfamily BOVINAE

Genus *Boselaphus* Blainville, 1816

17. *Boselaphus tragocamelus* (Pallas 1766)

Blue Bull

1766. *Antilope tragocamelus* Pallas, *Misc. Zool.*, p. 5.

Species Observed : Very high population inhabits the Nalsarovar wetland and found to visit the lake margins frequently.

Diagnostic characters : Male iron-grey with a white ring below each fetlock and two white spots on its cheek; horns not ringed but distinctly keeled in front; females and young males sandy brown. Both diurnal and nocturnal.

Distribution : India: From base of Himalayas to Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and Uttar Pradesh.

Elsewhere : Nepal and Pakistan. Introduced into Texas (U.S.A.).

Remarks : Agricultural field in the Ranagadh, Mulbaval, Parali up to Bagodra and in the cultivated fields of Durgi and Vekariya villages has the presence of this species. Rarely seen approaching the lake margins except once in the Durgi area where an adult was found in the Nal wetland.

Status : IUCN : LRcd; IWPA : Schedule III; CAMP : LR1c (Nationally); DD (Globally).

Order RODENTIA

Suborder SCIUROGNATHI

Family SCIURIDAE

Subfamily SCIURINAE

Genus *Funambulus* Lesson, 1835

18. *Funambulus pennantii* Wroughton, 1905

Northern Palm Squirrel

1905. *Funambulus pennantii* Wroughton, *J. Bombay nat. Hist. Soc.*, 16 : 411 (Mandvi Taluka, Surat, Gujarat, India).

Species Observed : In almost all bets which get connected to the land very soon after the monsoon inundation of the Nalsarovar and also in the Forested area around the lake.

Diagnostic characters : Small in size, ears rounded, and muzzle pointed. Dorsum grey and divided by three cream coloured stripes and distinctly separated from belly by indistinct creamy buff longitudinal strip. Tail bushy with whitish or creamy tip.

Distribution : India: Andaman Islands, Assam, Bihar, Delhi, Gujarat, Haryana, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Sikkim, Uttar Pradesh and West Bengal.

Elsewhere : Afganistan, Pakistan, Iran, Nepal and Bangladesh.

Remarks : Most commonly found around abandoned buildings inside forested zone and human habitations in and around the bird sanctuary.

Status : IWPA : Schedule IV; CAMP : LR1c (Nationally); DD (Globally).

Family MURIDAE

Subfamily GERBILLINAE

Genus *Meriones* Illiger, 1811

19. *Meriones hurrianae* (Jordon, 1867)

Indian Desert Gerbil

1867. *Gerbillus hurrianae* Jordon, *Mamm. India*, p. 186.

Species Observed : Large population exists in the land margins of the lake and on some bets in the Nalsarovar. Devthali, Shiyal, Dharabla, Nan chera, Forst Guest House area towards Vekariya and in the Parali region near the wetland.

Diagnostic characters : Sandy grey to brownish grey, under parts pale yellow to dirty white, tail hairy and tufted with a black streak on dorsal surface of tail. Diurnal and fossorial.

Distribution : India : Gujarat, Haryana, Punjab and Rajasthan.

Elsewhere : Afghanistan, Iran and Pakistan.

Remarks : They were mostly sighted in the areas around Nani Katheki, Shapura, Vekariya and in the Durgi village area adjacent to the lake.

Status : IWPA : Schedule V; CAMP: LR1c (Nationally); DD (Globally).

Genus *Tatera* Lataste, 1882

20. *Tatera indica* (Hardwicke, 1807)

Indian Gerbil

1807. *Dipus indicus* Hardwicke, *Trans. Linn. Soc. London*, 8 : 279.

Species Observed : Found on the Pan Bet having many holes in the root zone of the *Salvadora persica* tree species.

Diagnostic characters : Foot comparatively longer, soles naked to heel, tail clothed with hair and tufted at tip; upper parts sandy brown to reddish brown, under surface white; tail dark above and below and pale on sides; hind foot white. Nocturnal and fossorial.

Distribution : India : Andhra Pradesh, Bihar, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

Remarks : It was difficult to estimate that the species is thriving well on the bet which gets surrounded with water for over 6 to 8 months in the year.

Status : IWPA : Schedule V; CAMP: LR1c (Nationally); DD (Globally).

Subfamily MURINAE

Genus *Bandicota* Gray, 1873

21. *Bandicota bengalensis* (Gray and Hardwicke, 1833)

Lesser Bandicoot Rat

1833. *Arvicola bengalensis* Gray and Hardwicke, *Illustr. Ind. Zool*, 2. pl. 21 *Type locality* : Bengal, India.

Species Observed : Abundantly found in the near vicinity village of Nani Katechi of the Nalsarovar wetland.

Diagnostic characters : Body greyish brown to blackish dorsal surface, in some with reddish hue, light to dark grey ventral surface, snout less pointed, tail shorter than head and body. Nocturnal and fossorial.

Distribution : India : Throughout.

Elsewhere : Indo-China, Indonesia, Myanmar, Nepal, Pakistan and Sri Lanka.

Remarks : Raptors were found preying on them when they approach the lake margins for a dry fish in the area.

Status : IWPA : Schedule V; CAMP : LR1c (Nationally); DD (Globally).

22. *Bandicota indica* (Bechstein, 1800)

Large Bandicoot Rat

1800. *Mus indicus* Bechstein, In Pennant, *Uber Vierf Thiere*, 2: 497. *Type locality*: Pondicherry, India.

Species Observed : Forest GH, Vekariya village, Durgi, and Ranagadh village has very high population of the bandicoots.

Diagnostic characters : Body dorsal surface blackish brown, in some with pale yellowish or whitish hue, greyish brown ventral surface, snout less pointed, slightly larger and tail subequal to the head and body. Nocturnal and fossorial.

Distribution : India : Throughout.

Elsewhere : Bangladesh, China, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan, Thailand, Vietnam.

Remarks : A teeming population of giant rat can be seen in the day time also roaming the near vicinity of the lake for food.

Status : IWPA : Schedule V; CAMP: LR1c (Nationally); DD (Globally).

Genus *Mus* Linnaeus, 1758

23. *Mus musculus* Linnaeus, 1758

House Mouse

1758. *Mus musculus* Linnaeus, *Syst. Nat.* 10th ed., 1 : 62.

Species Observed : Mostly found in the forest GH area and in the village huts in the Nani Katechi village.

Diagnostic characters : Body sandy brown to dark brown above and white to ochraceous brown below. Nocturnal.

Distribution : Throughout.

Elsewhere : spread throughout most of world its close association with human habitation.

Remarks : The species was found in good numbers around the populated villages of Nal.

Status : IWPA : Schedule V; CAMP : LR1c (Nationally); DD (Globally).

Genus *Rattus* Fischer, 1803

24. *Rattus rattus* (Linnaeus, 1758)

House Rat

1758. *Mus rattus* Linnaeus, *Syst. Nat.*, 10th, 1, 61. *Type locality* : Uppsala, Sweden.

Species Observed : Forest Guest House and the Vekaria village.

Diagnostic characters : Medium size, belly without rusty tinge; tails dark in colour and longer than head and body.

Distribution : India : Throughout.

Elsewhere : Introduced world wide in the tropics and temperate zones.

Remarks : Frequently encountered in large numbers around abandoned buildings and dwellings in the area.

Status : IWPA : Schedule V; CAMP : LR1c (Nationally); DD (Globally).

Order LAGOMORPHA

Family LEPORIDAE Fischer, 1817

Genus *Lepus* Linnaeus, 1758

25. *Lepus nigricollis* Cuvier, 1823

Indian Hare or Black-napped Hare

1823. *Lepus nigricollis* Cuvier, *Diet Sci. Nat.*, 26 : 307. *Type locality* : Malabar, Tamil Nadu, India.

Species Observed : Forested land in the Shapura, Mulbavala, Ranagadh, and Parali region is rich in hare population.

Diagnostic characters : Dark brown or black patch on its neck from ears to shoulders and upper surface of tail black distinguishes it from other species.

Distribution : India: Throughout. *Elsewhere* : Bangladesh, Bhutan, Indonesia, Pakistan and Sri Lanka.

Remarks : Commonly found throughout the area. Variation in their length and shade of the coat was noticed as compared to the same species observed in other places of Rajasthan.

Status : IWPA : Schedule IV; CAMP : LR1c (Nationally); DD (Globally).

7. THREATS AND CONSERVATION

Wetlands have attracted greater attention during past few years for their ecological, biological, and economic role in the natural ecosystem. Ecologically, wetlands have been viewed as transitional between open water and terrestrial ecosystems. They are endowed with specific structural and functional attributes performing major ecological function as a result of land water inter-action. Their biological richness of species diversity has a wider role to play in balancing the needs of a regional geographic zone.

With the increase in population of the country, the pressure on wetlands is increasingly becoming unbearable to these fragile ecosystems of the land. The present state of health of these entities is deteriorating not only on account of their excessive exploitation but also largely due to neighbouring activities in the catchment area and unsustainable economic development.

Nalsarovar is one such example of deteriorating natural wetland facing serious threats because various such factors which in turn resulting in rapid degradation of water quality and decrease in biological diversity of the lake. Its ecosystem is now alarmingly under pressure due to both natural and man made factors such as over exploitation of the fisheries resource, severe human intervention, overexploitation of other wetland resources, adjoining human settlement activities and air pollution due to charcoal manufacturing in and around the lake. Unregulated and excessive tourism and boat movement is also adding to the degradation and health of the wetland.

Some of the major threats faced by Nalsarovar are as Fishing Activity, Unregulated Grazing of Aquatic Vegetation, Trapping and Poaching of Birds, Encroachment of Bets by Cattle Owners, Fodder Harvesting from the Lake by local inhabitants, Unregulated and Excess Pumping of Water for Irrigation, Trespass by Boat / Motor Vehicles on dried areas of the Lake and Tourism Pressure (Fig. 20).

Physiography of the Lake

Nalsarovar is a unique fresh water shallow lake with an area of 11,500 ha. The area of Nalsarovar Bird Sanctuary is 12,082 ha. Nalsarovar is located between 22°78 N to 22°96 N

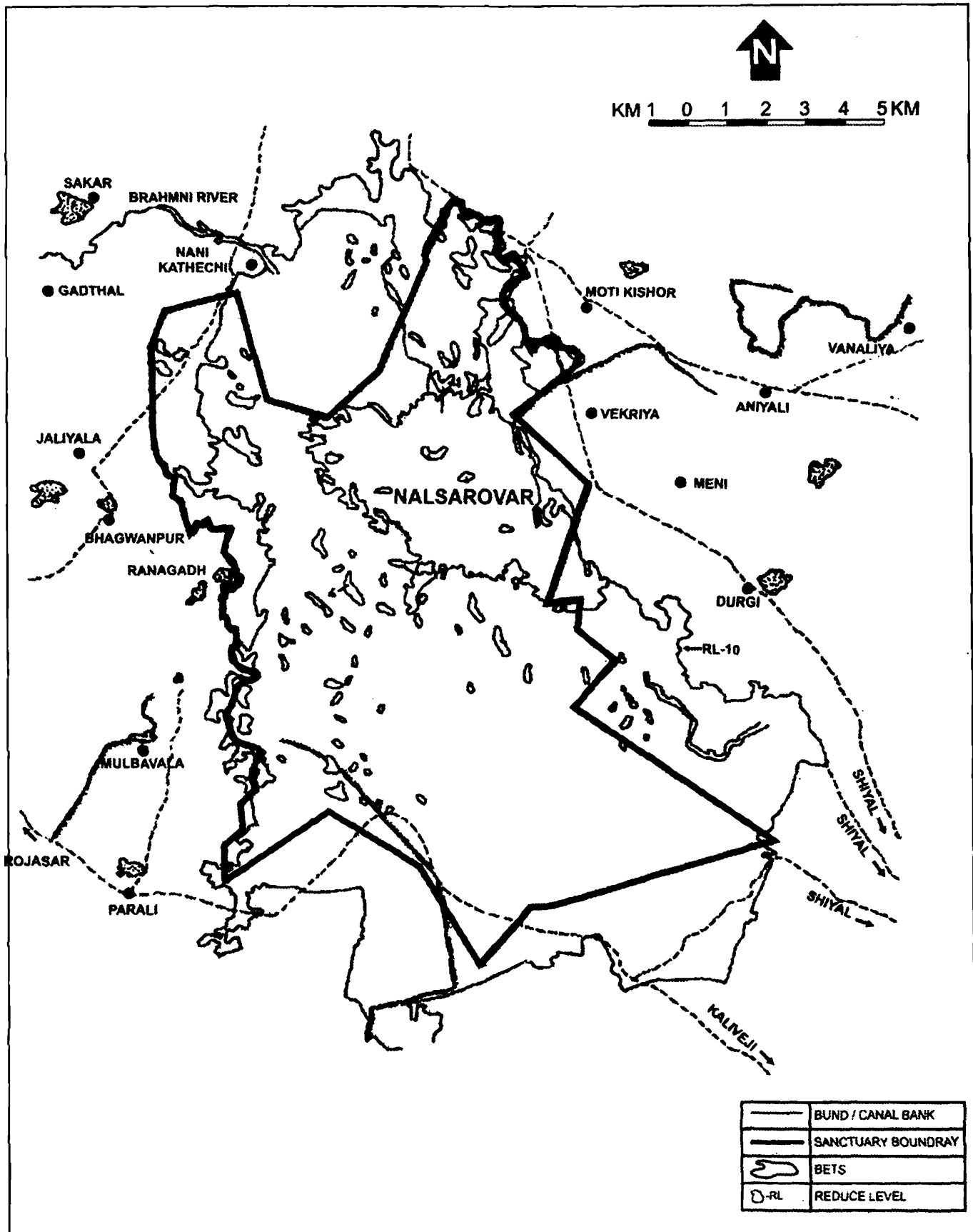


Fig. 20 : Map of Nalsarovar Wetland, Gujarat

latitude and 71°92 E to 72°64 E longitude in Surendranagar and Ahmedabad districts of Gujarat. It is situated at an altitude of 9.2 m. Nalsarovar is owned by State. It is believed that the tectonic upliftment, increased sedimentation and aeolian infill have reduced the estuary which links the Gulf of Khambhat with the Little Rann of Kachchh to a series of saline flats and a large freshwater lake, Nalsarovar with extensive marshes. The terrain is uniformly flat. It is surrounded by extensive marshes and reed beds. The lake is fed entirely by rivers Bhogavo, Bharmani and the catchment's run-off dependent upon monsoon rainfall. The lake dries up completely in years of low rainfall and even in wet years it almost dry by early summer. It was reported to have dried up completely in the year 1986. During the present survey from 1999-2003 the lake drying was observed exposing the bottom. The lake completely dried up in the year 2002-2003.

During very heavy monsoons, the water may be two meters deep. The lake harbours about 360 bets. 36 of these bets are fairly large and elevated. These bets remain submerged in water and are exposed when water recedes (Fig. 20). Salinity range from fresh water to slightly brackish in summer. Nalsarovar is characterized by dry, tropical monsoon climate with rainfall from southwest monsoon. Annual rainfall being 400 mm. The lake has no weather station of its own for recording the seasonal climatic changes at Nalsarovar. The data available for Sanand taluka, nearest place to Nalsarovar is taken as standard data for Nalsarovar bird sanctuary.

The Nalsarovar has rich aquatic vegetation supporting a vast diversity of faunal elements. Hydrophytes are represented by *Chara*, *Potamogeton*, *Najas*, *vallisneria*, *Nymphaea*, *Limnanthemum*, *Lemna*, *Wolfia* and *Hydrilla*. The semi-aquatic and marsh-land zones supports *Ammannia bacciferu*, *A. multiflora*, *Bergia* sp., *Alternanthera sessileis*, *Cyperus* sp., *Scirpus* sp., *Polygonum plebeium* and *Marsilea aegyptiaca*. Surrounding agriculture land supports crops of cotton, cereals, pulses and groundnut. The trees species in the region include *Prosopis juliflora*, *Prosopis spicigera*, *Salvadora persica*, *Salvadora oleoides* and *Acacia nilotica*. Nalsarovar Lake is protected in the Nalsarovar Bird sanctuary established in 1969. An area of approximately 100 ha as core zone is kept free from all disturbances.

The principal activities at Nalsarovar are fishing, grazing by domestic livestock, cutting of aquatic vegetation for fodder and outdoor recreation. Many people ply boats during tourist season for visitors especially bird watchers. The *Padhar* tribals are the main local inhabitants others than the *Kholipatels* and *Muslims* around Nal wetland.

Factors Causing Degradation of Aquatic Ecosystem of Nalsarovar Wetland

Nalsarovar is one of the unique largest shallow lake associated with high population of waterfowl, probably one of the highest in the country qualifying Nal for consideration as the wetland of international importance. The lake supports large number of faunal elements especially species of birds, (including migratory birds) as it is situated on the migratory route of birds. Nal has a high scientific research, educational and recreational value. The highest number of visitors amongst all PAs in the State visit this bird sanctuary (about 1.5 lakh

people visit annually). The ever increasing human and cattle population around Nal is over-exploiting the natural products from the wetland such as food, fodder, fuel and water. Poaching and shooting for enjoyment has increased due to less protection. The large population of birds visiting the near by agriculture fields are considered as nuisance and being shot frequently to save crops from yield losses.

The Nalsarovar at present vividly supports 410 species of invertebrates and vertebrate diversity with 83 floral species. It needs to be protected and conserved for fulfilling the needs of its local inhabitants and the wildlife. At the same time the environs of Nal has to be managed as it earns revenue to the state as a tourist centre and nature - lover's paradise. Some of the main threats faced by Nalsarovar are as discussed (Fig. 21; Plates 9 to 12).

Main Threats to Nalsarovar

1. Unregulated Fishing Activity
2. Unregulated Grazing of Aquatic Vegetation
3. Trapping and Poaching of Birds
4. Encroachment of Bets by Cattle Owners
5. Fodder Harvesting from the Lake by Local Inhabitants
6. Unregulated and Excess Pumping of Water for Irrigation
7. Trespass by Boat/ Motor Vehicles on dried areas of the Lake
8. Air Pollution
9. Tourism Pressure

1. Fishing Activity

Wetlands have always influenced the development of human society's time immemorial. But unregulated and excessive harvesting of fishes by the local people inhabiting the area causes serious and series of problems to the wetland and other partners of this unique biotic provenance.

Seed of fish species when comes to the lake with rain water through rivers from the catchment's area remain sufficient only to the biotic regulation of the aquatic ecosystem and not for commercial exploitation especially when the waterfowl population congregates very high on a particular wetland.

Fish harvesting for human consumption by the local people needs to be supplement by stocking seedlings by fishery department of the state and also the harvesting technique and net mesh size should be regulated so as to have regular harvesting of fishes.

Nalsarovar is facing serious problem due to heavy pressure of fish harvesting mainly on account of unregulated methods employed and excessive extraction of fishes irrespective of their size and species (Fig. 22). This has resulted into depletion of biotic resources for other partner of the wetland especially fish eating wetland and wetland dependant birds. Regulatory

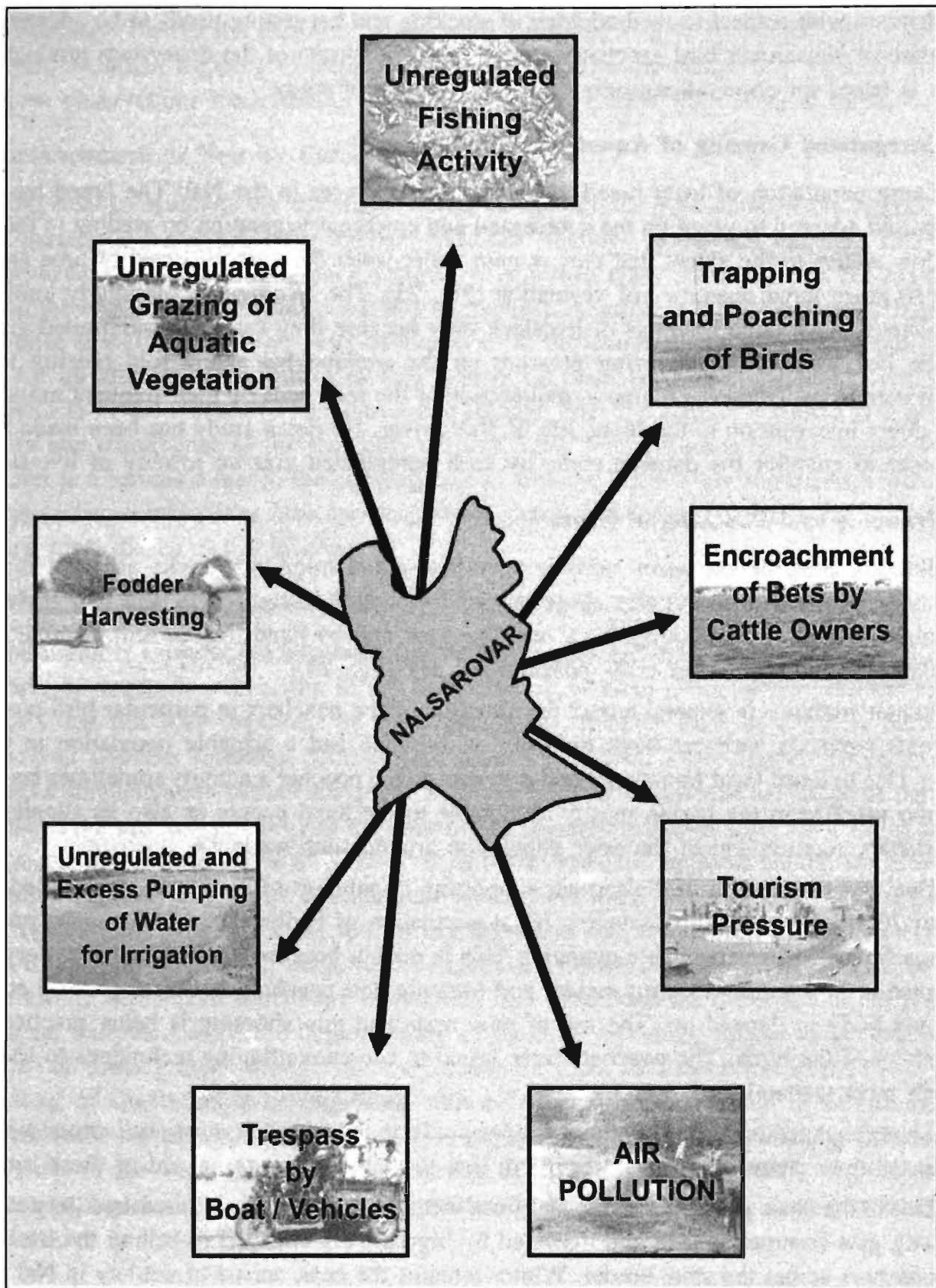


Fig. 21 : Theats to Lake Nalsarovar

mechanism with respect to methodology of stocking and harvesting needs to be addressed in the case of Nalsarovar bird sanctuary to ripe the better fruits of the ecosystem productivity. This is based on observations only during the course of study.

2. Unregulated Grazing of Aquatic Vegetation

Large population of local breed of buffalo freely grazes in the Nal. The breed has over the period adapted to graze on the submerged and emergent vegetation by wading in the lake shallow waters to the extent that they remain under-water for a good period of time and are able to graze large quantities of vegetation (Fig. 23). The “*Kolipatels*” popularly known as “*Maldaris*” have large holdings of livestock only because they can afford unlimited grazing in the Nal wetland. The grazing pressure on the wetland has many fold bearing to the ecosystem in depleting the biomass, molestation of the reed beds by their frequent movement and direct intervention to the biotic life of Nalsarovar. No detail study has been made so far in order to quantify the damage made by such unregulated grazing activity of live-stock.

3. Trapping and Poaching of Birds

Hunting pressure on water birds is very heavy and migratory ducks are shot in large numbers for the sale in the city. A variety of methods are used to kill and trap avifauna - slinging, netting, gun shooting, hook and line gear and by hand. No current information is available on the number of birds poached per day (Fig. 24).

Indian wetlands in general attract the attention of the poachers in particular bird poachers as most wetlands harbours large diversity of avifauna and a sizeable population to poach upon. Due to loose legal framework and easy escape the poacher’s activity sometimes becomes regular practice in the region mostly acceptable to the local people as also its supplements the dietary requirement of the poor population around such wetlands.

Due to vast expanse of Nalsarovar supporting population of more than 34000 people in about 20 villages around it including tribal population of Padhar and Muslims, the pressure of poaching is of unimaginable quantum. This is mainly because the Nal harbours very high population of waterfowl during winter and trapping and poaching becomes an easy activity for any body to depend on. The use of mist nests and gun shooting is being practiced for poaching of the birds. The poachers were found to use camouflaging techniques to trap and poach most wetland birds.

Those engaged in such poaching activities put forth a theory that most piscivorous avifauna consume their share of food and hence in lieu to that they try to get rid of these birds.

Due to the close proximity of the Nal from metropolitan city like Ahmedabad the poaching activity gets commercialized and managed by big partners engaged in selling the bird catch by poachers across the state border. Winter remains the peak period of activity in Nal as the water spread remains in a large area sometimes not accessible by the patrolling parties of forest Department with their limited resources. In most cases poaching is done in connivance with local inhabitants especially tribals and in disguise the whole activity is commercialized

to earn-money. During the period of study large scale poaching of flamingos, many species of ducks, including trapping of passerines were recorded in the Nalsarovar wetland. This is based on observations made during the course of study period from 1999 to 2003.

4. Encroachment of Bets by Cattle Owners

Kolipatels or Maldaris are the major holder of the buffalo population in the region. Not alone grazing is being practiced by their livestock holdings in the Nal but they also take shelter on bets within the Nalsarovar wetland. After a long entry inside the Nal, the Maldaris stay on the bets with their buffalo and this is practiced throughout the Nal wherever bets are of suitable size (Fig. 25). With onset of monsoon till the water recedes to a substantially low level i.e. up to the end of April-May they remain on these bets causing direct interference to avian life of the wetland. Their movement through boat for various purposes is a serious concern and disturbance to the lake environment. Their long presence in Nal during whole of winter is a serious threat to the congregation of wetland birds in the Nalsarovar. Members of many other communities also encroach upon certain bets during tourist season in winter offering local dishes to the tourists.

5. Fodder Harvesting from the Lake by Local Inhabitants

Nalsarovar is a unique wetland with reed sedge, grasses and cattails grow abundantly. The macrophytic vegetation occurring in the Nal areas are of great economic importance to the avifauna and this also exploited by local inhabitants. Species such as *Cyperus balbosus* (Thek) and *Cyperus rotundus* (Chingo) are taken as food by local people. These species possesses aerenchymous tissues and plays an important role in gaseous exchange of carbon-dioxide (CO₂) and oxygen (O₂) to the submerged vegetation. Large scale removal of reeds and grasses is a serious threat to Nalsarovar as these reeds are the ideal habitat for breeding of many wetland avian species. If large-scale removals of these grasses are being done it may cause regeneration problem of the species in a condition where lake becomes completely dry often. In the year 2002-2003 when the lake completely dried after 16 years it was observed that even the herbaceous roots were extensively harvested from the dried bed of the Nal. In almost all the years when the larger portion of the lake gets dried up the local inhabitants extract out these grasses along with their tuberous roots as fodder for livestock. If this harvesting of vegetation is not regulated with ever increasing population of human beings and livestock, the pressure might result into depletion of biomass and thereby threatening uniqueness of the wetland (Fig. 26). Harvesting of grasses is a direct biotic interference to winter congregation of avian species, destabilizing the nesting and roosting population of avian species in the Nal.

6. Unregulated and Excessive Pumping of Water for Irrigation

Nalsarovar is situated in the drought prone districts of Ahmedabad and Surendranagar in the state of Gujarat. Irrigation in this area is not very common. Cotton, rice, pulses, jowar

and bajra are the main kharif crops cultivated around Nalsarovar wetland. Whereas, crops like wheat, barley and some spices are grown during winter. Paddy along with many other crops is grown in and around Nalsarovar wetland on the basis of availability of water level after the monsoon. The local farmers use the difference of water level with most ingenuity utilizing the two rather stringent conditions of water level i.e. water level in their fields should not rise much otherwise their crops may be submerged or else water level should not recede too fast otherwise their crops may wilt. The other crops cultivated around Nalsarovar need irrigation up to late winter and the main source of irrigation is water available in the Nalsarovar. The water of the Nal is harvested or tapped in two ways: agriculture fields adjacent to Nal are irrigated by operating diesel genset, using collapsible pipeline to draw the water from the Nalsarovar wetland (Fig. 27). Whereas crop fields located at a distance from the margins of the lake are irrigated by drawing water through a channel dugged in the land and water is collected in a shallow expanse of land outside the Nal area from where again the diesel genset is used to pump water to their fields at a distance. During low rainfall years this activity adversely affects the water level in the Nal thereby jeopardizing the suitability of habitat ecology for waterfowls and other biota of the lake. Irrigation around the Nalsarovar need to be regulated by irrigation department of the Govt. in consultation with fisheries department and also state forest department who owns the responsibility of balancing the land ecology of the aquatic environment as also the resources.

7. Trespass by Boat/Motor Vehicles on Dried Areas of Lake

The boat plying in the lake on account of fishing activity, tourist movement and *Maldaris* movement during winter is a common feature in the Nalsarovar wetland. The local population also trespass Nal from Vekaria to Ranagadh, Nani Kathechi, from Dogri to Mullvabla and Parali by boat during high inundation years of the lake. This may seem to be a negligible intervention to the lake ecosystem but has very high negative impact on the congregating avian species in the Nal. Flocks of birds have been seen shifting from one place to another throughout the day due to frequent plying of boats. This severely affects their feeding and roosting behaviour and may result into aversion from the lake habitat. It has also been observed that during early summer upto the next monsoon when the lake margins gets dried up to a greater extent even the motorable vehicles also ply between the villages across the Nal thereby affecting the congregations of cranes and other passerines in the region (Fig. 28). As the water recedes near margins, the dried portion is being utilized for such trespass creating severe hindrance to the fauna especially the surface biota and the avian species of the lake.

8. Air Pollution

As the population of villages is growing up around Nalsarovar wetland, the pressures to harvest resources are also becoming alarmingly large and uncontrollable. Erratic rainfall and climatic changes in the catchment area is also accentuating already grim situation of the Nalsarovar. During less rainfall or drought years the local inhabitants are searching newer means to sustain lively hood other than migrating to the near by urban areas as labours. The

Villayti babul or the *Prosopis juliflora* and the *Acacia nilotica* are harvested from and around the Nalsarovar wetland and soft coke is manufactured by the villagers. This activity or so called small scale industry causes huge amount of smoke and heat in the region as hundreds of such manufacturing units operate in open in the near vicinity of Nalsarovar wetland thereby causing air pollution and nuisances to the locally migrating flocks of birds in and around Nal wetland (Fig. 29). Many species roost outside the Nalsarovar lake bed after their feeding in the shallow waters of the lake. Such avian elements get severe set back when such large scale activity is carried out in the fallow land around the lake.

9. Tourist Pressure

Wetlands are centre of tourist attraction mainly because of boating, angling of fish and of course a place to watch avian fauna. The vast expanse of Nalsarovar wetland provides golden opportunity to a tourist not only to do boating or angling of fish but to have more spectacular view of waterfowls.

Nalsarovar is on the international map of tourism and large number of foreign and domestic tourist visits this lake almost round the year except during rainy season. Uncontrolled and insensitive tourist traffic to this lake is leading to deterioration of its health by various ways. The frequent to and fro plying of boats both for taking the tourist for a trip in the lake are one among the most hazardous activity in polluting the lake environment. Further to add in these are the left over garbage like polyethylene bags, tins, glass bottles and waste food material, enough to pollute and deteriorate the lake waters. Since the magnitude of the tourist visiting this lake is very high, the amount of polluting material left is also proportionately very huge (Fig. 30).

The wildlife tourism has taken over the earlier concept from pilgrimage tourism. Today the urban population of cities living in concrete jungle needs to be exposed to the nature and hence the concept of eco-tourism is catching up very fast. Nalsarovar is just 60 km from city of Ahmedabad and hence it attracts large number of tourists to the lake during winter season the inflow of tourist's increases beyond the threshold capacity to accommodate and allure wildlife nature lovers to enjoy the placid water and serenity of Nal wetland. At present there is no regulatory mechanism to control and monitor the tourist activity in the region except that they are been regulated to pay entry fee. Unrestricted and uncontrolled movement of visitors in the bird sanctuary area causes greater disturbance to the avian congregation inhabiting the beds, open waters and reed beds of the lake. Weekend holidays are the days when inflow of tourists increases many fold with luxury vehicles and buses thronging the entry point with their whistling sound and emission of fuel exhaust in the ambient environment of the lake.

Conservation Strategies

Nalsarovar Lake has been proposed as a Wetland of International Importance under the Ramsar Convention. A number of suggestions with regard to the management of the sanctuary by the state Government such as establishment of a special committee to investigate the

problems of Nalsarovar; establishment of a special education and tourist centre at the existing recreation complex; designation of boating lanes and demarcation of disturbance free zones; strict protection of all the major islands, particularly during the bird breeding season; construction of fully equipped observation hides and planting of *Acacia nilotica* trees on some of the islands to provide nesting sites for large waterbirds have been made by IUCN (in prep); Koning and Koning-Raat (1975); Daniel (1985); Karpowicz (1985); WWF INDIA (1987), Garg *et al.* (1998), GEER (1998), Anon. (1990-2000), Garg (2002 b), and Islam and Rahamani (2004).

Planting of trees like *Acacia nilotica*, *Prosopis cineraria*, *Salvadora persica* and *Salvadora oleoides*, *Ficus sp.*, *Azadirachta indica*, *Tamarandus indica* on the bays and surrounding area for nesting and roosting sites of avian species may enhance their breeding and population number in this pristine environment. Other multipurpose trees found successfully growing for tropical regions may also be planted for biodiversity conservation (Tewari and Srivastava, 2005).

The master plan for the sanctuary should include the surrounding villages and their percentage dependence on the wetland resources so that the welfare of the sanctuary can be clearly linked to the welfare of the local people. There had been a move to increase the sanctuary limits to include the 13.6% of the total wetland area, which falls outside the sanctuary boundary.

Nalsarovar is the largest protected inland wetland habitat in the state of Gujarat. It is one of the protected areas that fall into command area of the Sardar Sarovar Project (SSP) for which a multi-disciplinary expert group was formed. The feasibility of storage of water from Narmada in Nalsarovar, extent and manner of such storage and releasing the same for irrigation was worked out by GEER (1998). It was felt in 1993 that the use of Nalsarovar for storage may not be considered in immediate future. It was also felt that use of Nal for storage of SSP water would be counter productive and it would be advisable to consider the use of canal water only when the management is certain about its beneficial impacts. In 1994 it was felt that while storage for lift irrigation was possible at Nalsarovar, this may not be considered in view of environmental concerns and submergence involved. It was also debated other way round how SSP water can be utilized for the benefit of ecology of Nalsarovar, by providing water only when it is required to improve the conditions. A canal from the SSP may be joined with the lake when it brings positive impacts. This will provide an opportunity for all round improvement in the lives of the people.

From the foregoing account of threats to this lake it becomes explicitly clear that the lake is passing through a stage of far and many hydro-biological changes due to men's tinkering with environmental factors which may likely to deteriorate and damage the natural balancing of metabolic digestibility of a strategically important manmade wetland ecosystem. It is, therefore, necessary to look into all the factors independently and also collectively to evolve an acceptable strategy whereby both nature and man can sustainably live together and contribute advantages to remain viable for years and centuries to come.

Forest Department has taken steps towards conservation of Nalsarovar wetland by initiating afforestation activities for stabilization of bays and habitat development of wetland avian fauna for visiting tourists so that they may not disturb the natural habitat and existing biodiversity of Nalsarovar. The state government has also taken steps for conservation by constructing a tourist complex at Nalsarovar. Nalsarovar need to be conserved not alone as ecotourism place but also as a hot spot of biodiversity for scientific research (Plate 7 & 8).

Suggestions for Conservation of Nalsarovar Wetland

- Regulatory mechanism with respect to stocking, harvesting methodology of fishes needs to be addressed in the case of Nalsarovar bird sanctuary to reap the better fruits of the ecosystem.
- Excessive grazing is seriously affecting the life and age of Nalsarovar wetland. Detail studies are required in order to quantify the damage made by such unregulated grazing activity of live-stock. It is, therefore, important to have regulatory mechanism for grazing not only in the catchments area but also on the marginal forested land belt all around the lake. This will help to develop more luxuriant forest buffer for avian and other invertebrates and vertebrate population in the region.
- Poaching and trapping of birds is a common feature and if not stopped the people especially the children who live around the lake might also end up hunting the birds. They need to be educated about the importance of the lake, the birds and the benefit they draw from it. State Forest Department should continuously take assistance of local boatmen to patrol the lake during night hours and collect nets laid to capture birds. If poaching continues slowly the category of endangered and threatened birds will increase as happened with Hornbill, which was once reported in early days of its natural glory and also being depicted by the state Forest Department on the bird list of Nalsarovar.
- The Nalsarovar lake and the Nalsarovar Bird Sanctuary are owned by the State Government and the State Forest Department are the guardians of this immense natural wealth of the country. They should implement the forest laws and not to allow any permanent settlement inside the lake especially on the bays.
- The lake supports rich aquatic vegetation. The locals inhabiting near the lake needs to be made aware about the benefits they draw from harvesting of vegetation. They should be made aware of the fact that even for their own sustainability complete removal of roots is not desirable. They should be taught proper pruning and lopping of the vegetation to prevent depletion of biomass thereby threatening uniqueness of the wetland.
- Irrigation around the Nalsarovar need to be regulated by irrigation department of the Govt. in consultation with fisheries department and also state forest department who owns the responsibility of balancing the land ecology of the aquatic ecosystem as also the resources. Water from the Narmada canal may be channeled in time of water scarcity.
- Many birds breed on floating reed beds and other vegetation. Care should be taken in not destroying their nests by the plying boats and motor vehicles or even while walking near the bank.

- All boatmen to be given training to learn and identify birds and their nesting sites so as to row the boat in the lake with least disturbance to the breeding colonies of avian species. The maneuvering of the boat not disturbing the breeding bird population or their congregation can only be done by expert boatmen.
- The lake is an important visitor attraction and could be profitably utilized for stocking phytophagous fishes, which are good biological filters.
- Tourists need proper guidance and training by expert guides to observe birds without disturbing them or rather be a silent spectator in this bird paradise. They should learn to maintain the health of this ecosystem by carrying back the un-consumable litter with them.
- Tourism should be regulated by utilizing the services of nationally acclaimed technical experts to regulate plying of boats and inflow of tourists.
- Nominal fees are being charged at the entry. It should be increased and heavy fine levied for polluting the environment with litter.
- Air pollution due to charcoal manufacturing from *Prosopis juliflora* should be minimized.
- Regular monitoring and update exact mapping of the lake and its surrounding areas through remote sensing technique is required.
- Remote sensing also to be used especially for habitat conservation and avian species documentation.
- The Nalsarovar bird sanctuary should have a weather station of its own for recording the seasonal climatic changes at Nalsarovar with respect to seasonal abundance and change in behaviour of avian species especially the arrival and departure of wintering migratory and resident birds.
- A computerized systematic data based on socio-economic aspects of the people dependent on the lake needs to be developed to interpret each individual element of dependence in a wetland of this nature.
- The management plan needs to be updated in the present contest and the lake soon to be protected from the increasing threats to save its uniqueness and its rich biodiversity.
- The recreation complex at the Lake established by Gujarat Tourist Department and now in the control of State Forest Department needs to be updated and well equipped with latest monitoring equipments and a computerized bird observatory as Nal is on the migratory route of avian species.
- Building up awareness amongst the people directly drawing benefit from the lake as also those involved in implementation/execution of policies of the Government as a paramount measure in reducing the potential threats to the Nalsarovar.
- Sensitization of the importance and the problems of wetlands amongst scientists, students, NGO's and any one who is connected directly or indirectly to these jewels of the civilization can save them from becoming lands of dry earth.
- Planting of multipurpose trees like *Acacia nilotica*, *Prosopis cineraria*, *Salvadora persica*

and *Salvadora oleoides*, *Ficus* sp. *Azadirachta indica*, *Tamarindus indica*, *Melia* sp., on the beds and surrounding area for nesting and roosting sites of avian species may enhance their breeding and population number in this pristine environment and for biodiversity conservation.

- Perpetuation of reeds needs to be ensured by stopping over exploitation and judicious use and plantation.
- A canal from the SSP to be joined with the lake for positive impacts and to provide an opportunity for all round improvement in the lives of the people inhabiting the lake surroundings.
- Involvement of local people in all conservation activities.

Nalsarovar is the first bird sanctuary in India of International Importance, being identified as important bird area (IBA) and also proposed for declaration as a Ramsar site. It is still in its pristine glory and requires immediate conservation measures to prevent it from deteriorating due to the ever-increasing threats of human intervention.

8. SUMMARY

Nalsarovar is one of the unique largest shallow lakes associated with high population of waterfowl, probably one of the highest in the country qualifying for consideration as the wetland of international importance. The lake supports large numbers of faunal elements especially species of birds, (including migratory birds) as it is situated on the migratory route of birds. Nal has high scientific research, educational and recreational value as the highest numbers of visitors (about 1.5 lakh people visit annually) visit this sanctuary in the state. The lake should soon be protected from the increasing threats to save its uniqueness and its rich biodiversity.

In the present publication attempt has been made to work out the faunal diversity of Nalsarovar wetland along with its physico-chemical parameters, threats and suggestions for conservation strategies. From Protozoa to Mammalia, all the faunal groups available in and around Nalsarovar wetland were collected and have been identified as far as possible except where experts were not available. A total of 410 species of invertebrates and vertebrates have been recorded from Nalsarovar of which 246 are avian species. Out of the total taxa recorded, 137 species are reported for the first time from Nalsarovar.

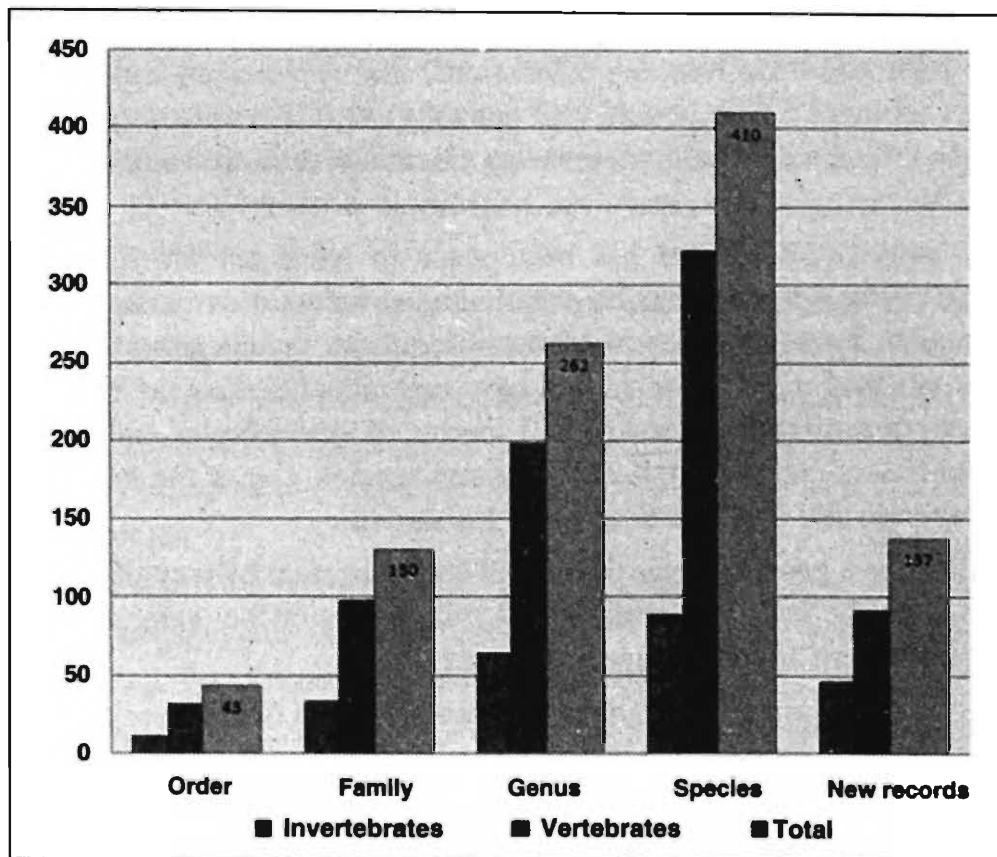
Nalsarovar wetland is a good example of cultural eutrophication by way of natural activities. The pH variations were the least and exhibited alkaline nature of the water. The water is rich in nutrients and consequent higher biomass of algae.

Rotifera were the most dominant group of zooplankton from Nalsarovar Lake represented by nineteen species and eleven genera belonging to nine families and three orders; Copepoda by four genera and four species under one family, regularly occurring along with nauplii throughout the study period. Cladocerans were represented by nine genera and twelve species. Protozoa and Ostracods were considered insignificant. Decapoda were represented by one

shrimp species and insecta by larvae of Diptera (Chironomidae, Psychodidae and Culicidae), Ephemeroptera, Plecoptera, Heteroptera and nymphs of odonate flies and many derelicts forms. In all 47 species of insects belonging to five orders viz. Dermaptera (6), Orthoptera (5), Heteroptera (11), Diptera (23) and Hymenoptera (2) of insecta: arthropoda are reported in the present study. One species of arthropoda: arachnida (1) was also reported from Nalsarovar as new record.

Dermaptera are represented by six species under four genera of two families of Dermaptera: Anisolabididae and Labiduridae All the species are recorded for the first time from Nalsarovar. Four species are new records from Gujarat. Five species of orthoptera under five genera and three families are recorded for the first time from Nalsarovar wetland, Gujarat. Heteroptera is represented by eleven species belonging to eight genera and five families. Ten species are new records from Nal. The present study also records twenty three species belonging to nineteen genera under ten families of Diptera from Nalsarovar, Gujarat. All the species of Diptera are documented scientifically for the first time from Nalsarovar. Two ant species distributed under two genera and two subfamilies viz. Myrmicinae and Formicinae of Family Formicidae of Order Hymenoptera are also first records from Nalsarovar Wetland, Gujarat.

Ichthyofauna of Nalsarovar is represented by 28 species belonging to 18 genera comprising 10 families under 5 orders with 20 new records and close affinity to fishes of Rajasthan, Punjab and Western Himalaya.



Summary : Total number of faunal species recorded from Nalsarovar Wetland, Gujarat

Seven species under five genera and three families of amphibia have been recorded from Nalsarovar. All species are new records from the wetland. Further studies may reveal many more species from the region.

The present account deals with sixteen species belonging to twelve genera under nine families. Five species viz. *Varanus salvator*, *Ophisops jerdoni*, *O. microlepis*, *Hemidactylus brooki* and *Hemidactylus leschenaulti* are reported for the first time from Nalsarovar wetland, Gujarat.

A total of 246 avian species under 141 genera and 54 families have been recorded from Nalsarovar been classified as water birds, water dependent and associated birds, reed dwellers and passerines birds. 49 species are new records to Nalsarovar wetland. Poaching and trapping of birds at Nalsarovar is a very common practice. Due to congregation of very high population of most avian species and lack of legal framework to control such activity, the ecosystem is facing severe setback and may be if not taken care the population may dwindle in future.

The paper records the sighting of twenty-five species of mammals belonging to six orders under twenty families. Ten species are reported as new records from Nalsarovar. The mammalian species reported are associated and found in the Nalsarovar wetland.

Nalsarovar is the first bird sanctuary in India being identified as important bird area (IBA site) and also proposed for declaration as a Ramsar site. It is still in its pristine glory and requires immediate conservation measures to prevent it from deterioration due to the ever-increasing threats of human intervention. The threats and suggestions for conservation are also discussed in detail.

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10. APPENDICES

10.1. Appendix 1 : List of Important Wetlands in India

State / UT	Total No. of Wetlands	Name of Wetlands
Andhra Pradesh	1	Kolleru
Assam	2	Deepar Beel Urpad Beel
Bihar	3	Kabar Barilla Kusheshwar Asthan
Gujarat	8	Nalsarovar Great Rann of Kachh Thol Bird Sanctuary Khijadiya Bird Sanctuary Little Rann of Kachh Pariej Wadhwana Nanikakrad
Haryana	2	Sultanpur Bhindawas
Himachal Pradesh	5	Renuka Pong Dam Chandratal Rewalsar Khajjiar
Jammu and Kashmir	7	Wullar Tso Morari Tisgul Tso & Chisul Marshes Hokersar Mansar-Surinsar Ranjitsagar Pangong Tso
Jharkhand	2	Udhwa Tilaiya Dam
Karnataka	7	Magadhi Gudavi Bird Sanctuary Bonai

State/UT	Total No. of Wetlands	Name of Wetlands
Kerala	5	Hidkal & Ghataprabha Heggeri Ranganthittu K.G. Koppa Ashtamudi Sasthamkotta Kottuli Kadulandi Vembnad Kol
Madhya Pradesh	11	Barna Yashwant Sagar Wetland of Ken River National Chambal Sanctuary Ghatigaon Ratapani Denwa Tawa Kanha Tiger Reserve Pench Tiger Reserve Sakhyasagar Dihaila
Maharashtra	3	Ujni Jayakawadi Nalganga
Manipur	1	Loktak
Mizoram	2	Palak Tamdil
Orissa	4	Chilika Kuanria Kanjia Daha
Punjab	3	Harike Ropar Kanqli
Rajasthan	1	Sambhar

State/UT	Total No. of Wetlands	Name of Wetlands
Sikkim	7	Khechuperi Holy Lake Tamze Tembao Wetland Complex Phendang Wetland Complex Gurudokmar Tsomgo
Tamil Nadu	3	Point Calimere Kaliveeli Pallaikarni
Tripura	1	Rudrasagar
Uttar Pradesh	9	Nawabganj Sandi Lakh Bahoshi Samaspur Alwara Semarai Lake-Nagaria Lake Complex Keetham Lake Shekha Saman Bird Sanctuary & Sasai Nawar Complex
Uttaranchal	1	Ban Ganga Jhilmil Tal
West Bengal	5	East Calcutta Wetlands Sunderbans Ahiron Beel Rasik Beel Santragahi
UT (Chandigarh)	1	Sukhna
Total Wetlands	94	

Source : Conservation of Wetlands in India : A profile, MoEF, 2007.

10.2. Appendix 2. Insecta : Heteroptera : (Aquatic and Semi aquatic)**G. Thirumalai, SRS, ZSI, Chennai**

Aquatic insects constitute less than 3% of global diversity in freshwater habitats and they represent 95% of all macro invertebrates in freshwater habitats (Cheng, 1976 and Ward, 1992). Out of 3000 species of Indian freshwater insects, the aquatic and semi aquatic bugs constitute 9.5% (Alfred and Nandhi, 2001). These bugs are not only play a vital role in food chain but also indicate long-term environmental conditions and constitute integral components of all freshwater communities (Hynes, 1984; Patrick, & Palavage, 1994; Ramakrishna, 2000). A few of the aquatic bugs are keystone predators, their abundance is essential to the existence of animal communities in an aquatic habitat (Murdoch *et al.*, 1984). These insects also serve as zoogeographical indicators because of their diverse habitats and poor dispersal capability (Jordon, 1951; Hungerford & Matsuda, 1958).

In spite of 79 genera and 284 species accommodated in 15 major families of aquatic and semi aquatic hemiptera known from India (Thirumalai, 1999; 2002; 2007 press), little information on water bugs of Nalsarovar wetland, Gujarat is available. Perusal of literature indicates that the aquatic and semi aquatic bugs of Gujarat belonging to the infra orders Gerromorpha and Nepomorpha received only rather cursory attention, chiefly taxonomic preliminaries including recording of species from different parts of the state (Anonymous, 1996; Thirumalai, 2002; 2007 press). The present inventory is based on the collection made available to the author from Nalsarovar wetland, Gujarat comprising of 11 species accommodated under 8 genera and 5 families out of which 10 species forms the first report of these infra orders from this wetland. Under each species, citation from the original description, diagnostic characters, distribution and other accompanying work necessary to understand the taxon or its occurrence in India is provided.

SYSTEMATIC LIST**Order HEMIPTERA****Suborder HETEROPTERA****Infraorder GERROMORPHA****Family GERRIDAE****Subfamily GERRINAE****Genus *Aquarius*****1. *Aquarius adelaidis* (Dohrn)****Genus *Limnogonus*****2. *Limnogonus (Limnogonus) fossarum fossarum* (Fabricius)**

Infraorder NEPOMORPHA

Family NEPIDAE

Subfamily RANATRINAE

Genus *Ranatra*

3. *Ranatra filiformis* Fabricius

Family BELOSTOMATIDAE

Subfamily BELOSTOMATINAE

Genus *Diplonychus*

4. *Diplonychus annulatum* (Fabricius)

5. *Diplonychus rusticus* (Fabricius)

Subfamily LETHOCERINAE

Genus *Lethocerus*

6. *Lethocerus indicus* (Lepeletier & Serville)

Family CORIXIDAE

Subfamily CORIXINAE

Genus *Agraptocorixa*

7. *Agraptocorixa (Agraptocorixa) hyalinipennis* (Fabricius)

Subfamily MICRONECTIIDAE

Genus *Micronecta*

8. *Micronecta (Basilonecta) scutellaris scutellaris* (Stål)

9. *Micronecta (Sigmonecta) quadristrigata* Breddin

Subfamily CYMATINAE

Genus *Cymatia*

10. †*Cymatia apparens* (Distant, 1910)

Family NOTONECTIDAE

Subfamily ANISOPINAE

Genus *Anisops*

11. *Anisops campbelli* Brooks

12. *Anisops cavifrons* Brooks

† The occurrence of the species marked † needs (Anonymous, 1996) further investigation.

SYSTEMATIC ACCOUNT

1. *Aquarius adelaidis* (Dohrn)

1860. *Aquarius adelaidis* Dohrn, *Stettin. ent. Ztg.*, 21 : 408.
 1990. *Aquarius adelaidis* (Dohrn) : Andersen, *Steenstrupia*, 16(4) : 61.
 1896. *Gerris spinolae* Leth. & Ser., *Cat.gen.Hemiptera*, 3 : 63.
 1903. *Gerris spinolae* (Leth. & Ser.) : Distant, *Fauna British India*, 2 : 180.

The first antennal segment is the longest, the head, rostrum, pronotum and forelegs are black. The hind margin of pronotum is brownish yellow; forewing dark brown in macropterous forms with dark brownish veins; the hind margin of the 7th sternum with a large triangular impression in middle. This is one of the very common species inhabiting the permanent water bodies in India, with both macropterous and apterous forms. This species is found in all lentic habitats and recorded from deep wells in Southern India.

Material examined : 1 ♀ (Winged), Ranagadh Bet, 29.iii.1999, Reg. No. 11056/5; 2 (Micropterous) & 1 immature, Pan Bet, 27.iii.2000, Reg. No. 11012/5, Coll: S. Kumar: all from Nalsarovar Wetland, Gujarat.

Distribution : Bangladesh; China; India (widely distributed); Indonesia; Myanmar; Nepal; Philippines; Srilanka; Thailand; Vietnam.

2. *Limnogonus (Limnogonus) fossarum fossarum* (Fabricius)

1775. *Cimex fossarum* Fabricius, *Syst. Ent.*, 727.
 1794. *Gerris fossarum* Fabricius, *Ent. Syst. emen. aucta*, IV : 188.
 1868. *Limnogonus fossarum* Stal, *K. Svenska Vetensk. Akad.*, 7 : 133.
 1959. *L. (Limnogonus) fossarum* (Fab.): Hungerford & Matsuda, *J. Kans. Ent. Soc.*, 32(1) : 40.
 1975. *L. (L.) fossarum* (Fab.): Andersen, *Ent. Scand. Suppl.*, 7 : 30.

A median yellow line on the anterior pronotal lobe extending to its entire length separates this species from all the known species. The connexivum does not terminate in a prominent spine. A very common species of Gerrinae in Indo-Australian regions, found in wide variety of habitats including hot springs, brackish pools, from Sea level to about 1000 meters.

Material examined : 3 ♂ & 6 ♀ (Apterous) & 24 immature, Nalsarovar, 29.iii.1999, 7736/5; 2 ♂ & 1 ♀ (Apterous), Pan and Dharabala Bet, 15.ii.2000, Reg. No. 78/6, Coll. S. Kumar; all from Nalsarovar Wetland, Gujarat.

Distribution : China; Hong Kong; India (very widely distributed); Indonesia; Japan; Malaysia; Myanmar; Philippines; Singapore; Taiwan; Thailand; Vietnam.

3. *Ranatra filiformis* Fabricius

1790. *Ranatra filiformis* Fabricius, *Skrit. Nat. Selsk.*, 1 : 228.
 1906. *Ranatra filiformis* Fabricius : Distant, *Fauna British India*, 3 : 21.

1972. *Ranatra filiformis* Fabricius : Lansbury, *Trans. R. Ent. Soc. Lond.*, **124** : 321.
 1994. *Ranatra filiformis* Fabricius : Thirumalai, *Misc. Occ. Pap. Rec zool. Surv. India*, **165** : 22.
 2001. *Ranatra filiformis* Fabricius : Thirumalai, ZSI, *Fauna of Conservation Area*, **11** : 118.
 1860. *Ranatra sordidula* Dohrn, *Stett. ent. Zeit.*, **21** : 409.
 1906. *Ranatra sordidula* Dohrn : Distant, *Fauna British India*, **3** : 22.

The males of this species can be identified by the absence of a tooth and presence of several small spines on the inner margins of distally hook shaped paramere and presence of wide interocular space. This species is smaller in size (20-30 mm) than *R. elongata*. This species is mostly found among vegetation, fringing the shallower parts of water, clinging to submerged vegetation and feeds on nymphs of dragonflies and mosquito pupae.

Material examined : 1 ♂, Pan Bet, 27.iii.2000, Reg. No. 11011/5 Coll: S. Kumar: all from Nalsarovar Wetland, Gujarat.

Distribution : India (very widely distributed); Nepal; Pakistan; Philippines; Sri Lanka.

4. *Diplonychus annulatus* (Fabricius)

1781. *Nepa annulata* Fabricius, *Carol. Ernest. Bokhni. Hamburgi et Kiloni*, 333.
 1832. *Belostoma marginata* Gray, *Griffith's Animal King., Insecta.*, **2** : 248.
 1833. *Sphaerodema rotundata* Laporte, *Systematique Hemipteres, zoologie, Paris* : 18.
 1863. *Sphaerodema annulatum* (Fabricius) : Dufour, *Ann. Soc. Entomol. France*, (4)**3** : 397.
 1906. *Sphaerodema annulatum* (Fabricius) : Distant, *Fauna British India*, **3** : 35.
 1947. *Sphaerodema annulatum* (Fabricius) : Hafiz and Pradhan, *Rec. Indian Mus.*, **45** : 375.
 1985. *Abedus sangameshwari* Rupavathi, *Ph. D Dissertation, Nagarjuna University, Andhra Pradesh*, 169.
 1995. *Diplonychus annulatus* (Fabr.) : Polhemus *et al*, *Proc. Entomol. Soc. Washington*, **97** : 651.
 2002. *Diplonychus annulatus* (Fabr.) : Thirumalai, Metha & Sharma, *Res. Bull. Panjab Univ.*, **52** : 157.

Size more than 20 mm with greatest expanse of hemelytra which together size up the body length. The fore tarsus is two segmented.

Material examined : 1 ♂ Near Shore area, Nalsarovar, 12.xii.2000, Reg. No. 221/6; 1 ♂, Lhasa Bet, 23.x.2001, Reg. No. 427/6; 1 ♀, Pan Bet, 7.xii.2000, Reg. No. 159/6; 1 ♂, Chera Bet, 14.x.2001, Reg. No. 452/6; Coll: S. Kumar: all from Nalsarovar Wetland, Gujarat.

Distribution : India (widely distributed); Pakistan; Taiwan.

5. *Diplonychus rusticus* (Fabricius)

1781. *Nepa rustica* Fabricius, *Species insectorum*, **2** : 333.
 1776. *Nepa plana* Sulzer, *abgek. Gesch. Insect*, 92.
 1863. *Appasus marginicollis* Dufour, *Ann. Soc. Ent. France*, **3(4)** : 393.
 1868. *Diplonychus rusticus* (Fab.) : Mayr *Zoolog. Teil Wien*, 188.
 1871. *Diplonychus rusticum* (Fab) : Mayr, *Verh. zool.-bot. Ges. Wien*, **21** : 437.
 1906. *Sphaerodema rusticum* (Fab.) : Distant, *Fauna British India*, **3** : 36.

1915. *Sphaerodema rustica* (Fab) : Bergroth, *J. Bombay nat. Hist.*, **24** : 179.
 1934. *Diplonychus rusticum* (Fab) : Lundblad, *Arch. Hydrobiol. Suppl.*, **12** : 55.
 1947. *Diplonychus rusticum* (Fab) : Hafiz & Pradhan, *Rec. Indian Mus.*, **45** : 374.
 1961. *Diplonychus rusticus* (Fab.) : Lauck & Menke, *Ann. Entomol. Soc. Amer.*, **54** : 649.
 1980. *Diplonychus indicus* Venkatesan & Rao, *J. Bombay. Nat. Hist. Soc.* **77** : 299.
 1994. *Diplonychus rusticus* (Fab.) : Thirumalai, *Misc. Occ. Pap. Rec. Zool. Surv. India*, **165** : 25.
 2005. *Diplonychus rusticus* (Fab.) : Thirumalai & Suresh Kumar, *Rec. zool. Surv. India*, **105** : 13.

This species has a single segmented fore tarsus with small claw, pale lateral basal margins of pronotum and its head length is shorter than the width between the eyes. This species is commonly found in fishponds and voraciously feeds on fish fry, mosquito larvae and other aquatic invertebrates.

Material examined : 1 ♀, Bamni River, 28.ii.2003, Reg. No. 498/6; 1 ♂, Bansori Bet, 22.x.2001, Reg. No. 399/6; 2 ♂, Lhasa Bet, 23.x.2001, Reg. No. 427/6; 1 ♂, Ranagadh, 29.iii.1999, Reg. No. 11057/5; 1 ♀, Limsi Bet, 28.iii.1999, Reg. No. 11034/5; 1 ♂, Vekriya, 8.xii.2000, Reg. No. 168/6, Coll: S. Kumar: all from Nalsarovar Wetland, Gujarat.

Distribution : Australia; China; India (very widely distributed); Indonesia; Japan; Malaysia; Myanmar; New Guinea; New Zealand; Srilanka; Thailand.

6. *Lethocerus indicus* (Lepeletier & Serville)

1825. *Belostoma indica* Lepeletier & Serville, *Encycl. Meth.*, **X** : 272.
 1871. *Belostoma indicum* Lepeletier & Serville : Mayr, *Verh. zool.-bot. Ges. Wien*, **21** : 426.
 1901. *Amorgius indicus* Kirkaldy, *Entomologist*, **34** : 51.
 1906. *Belostoma indicum* (Lepeletier & Serville) : Distant, *Fauna British India*, **3** : 38.
 1911. *Belostoma indica* Lepeletier & Serville : D'Abreu, *J. Bombay nat. Hist.*, **20** : 883.
 1927. *Lethocerus indicus* (Lep. & Serv.) : Torre-Bueno *Bull. Brooklyn Entomol. Soc.*, **22** : 30.
 1939. *Lethocerus indicus* (Lep. & Serv.) : Hafiz & Ribeiro, *Rec. Indian Mus.*, **41**(4) : 432.
 2004. *Lethocerus indicus* (Lep. & Serv.) : Thirumalai, *Rec. zool. Surv. India*, **102**(1-2) : 67.

The 'giant Indian water bug' large, elongate, dorsoventrally flattened brown aquatic bug; divergent yellow line on anterior lobe of pronotum broad; eyes twice as long as wide and elongate. Members of this genus are found in deeper water bodies such as pond, lakes, flooded paddy fields etc.

Material examined : 1 ♂ & 1 ♀, Dharabala Bet, 15.x.2001, Reg. No. 325/6; 1 ♂ & 1 ♀ Pan Bet, 17.x.2001, Reg. No. 361/6; 2 ♂, Durgi Bet, 23.x.2001, Reg. No. 783/6; 4 ♂ & 2 ♀, Bansori Bet, 16.x.2001, Reg. No. 324/6; 7 ♂ & 2 ♀ Mulbavala, 19.ii.2000, Reg. No. 125/6, Coll. S. Kumar; all from Nalsarovar Wetland, Gujarat.

Distribution : China; India (very widely distributed); Indonesia; Malaysia; Myanmar; Pakistan; Srilanka.

7. *Agraptocorixa (Agraptocorixa) hyalinipennis* (Fabricius)

1803. *Sigara hyalinipennis* Fabricius, *Syst. Rhyn Brusvigae*, 105.
 1918. *Corixa unicolor* Paiva, *Rec. Indian Mus.*, 14 : 30.
 1922. *Corixa paivana* Dover in Paiva & Dover, *Rec. Indian Mus.*, 24 : 333.
 1926. *Agraptocorixa hyalinipennis* (Fabricius) : Jaczewski, *Ann. Zool. Mus. Polon. Warsaw*, 5 : 18.
 1940. *Agraptocorixa (Agraptocorixa) hyalinipennis* (Fabricius) : Hutchinson, *Trans. Connecticut Acad. Art. Sci.*, 33 : 411.
 1989. *Agraptocorixa (Agraptocorixa) hyalinipennis* (Fabricius) : Thirumalai, *Misc. Occ. Pap. Rec. Zool. Surv. India*, 18 : 11.
 2002. *Agraptocorixa hyalinipennis* (Fabricius) : Thirumalai, Metha & Sharma, *Res. Bull. Panjab Univ.*, 52 : 157.
 2004. *Agraptocorixa hyalinipennis* (Fabricius) : Thirumalai, Sureshkumar & Sharma, *Zool. Surv. India, Conservation Area Series*, 20 : 243.

This species can be very easily recognized by its uniform hyaline brown coloration, unmarked elytra and pronotum. The abdominal sixth dorsum bearing the strigil, produced backwards as a well-defined peduncle. *A. hyalinipennis* is the only species of the genus so far known from India and commonly found to inhabit the ditches, puddles and stagnant pools in various parts of the country including Eastern and Western Ghats.

Material examined : 13♂ & 10♀, Shiyal Bet, 4.iii.2003, Reg. No. 542/6; 7♂ & 8♀, Ranagadh. W. T. Mulbavala, 5.xii.2003, Reg. No. 556/6; 1♂ & 2♀, Nani Kathechi, 2.iii.2003, Reg. No. 516/6, Coll: S. Kumar: all from Nalsarovar Wetland, Gujarat.

Distribution : India(very widely distributed); Myanmar; New Guinea; Pakistan; Taiwan.

8. *Micronecta (Basilonecta) scutellaris scutellaris* (Stål)

1858. *Sigra scutellaris* Stål, *Vetens akad. Forh.*, 15 : 319.
 1908. *Micronecta malabarica* Kirkaldy, *Canad. Ent.*, 40 : 209.
 1910. *Micronecta dione* Distant, *Fauna Brit. India*, 5 : 348.
 1910. *Micronecta malabarica* Kirkaldy: Distant, *Fauna Brit. India*, 5 : 347.
 1910. *Micronecta proba* Distant, *Fauna Brit. India*, 5 : 348.
 1940. *Micronecta. (Basilonecta) scutellaris scutellaris* (Stål) : Hutchinson, *Trans. Connecticut Acad. Art. Sci.*, 33 : 365.
 1940. *Micronecta scutellaris pseudostriata* Hutchinson, *Trans. Connecticut Acad. Art. Sci.*, 33 : 371.
 1947. *Micronecta (Basilonecta) scutellaris scutellaris* (Stål) : Hafiz and Pradhan, *Rec. Indian. Mus.*, 45 : 354.
 1994. *Micronecta (Basilonecta) scutellaris scutellaris* (Stål) : Thirumalai, *Misc. Occ. Pap. Rec. Zool. Surv. India*, 165 : 9.
 2005. *Micronecta (Basilonecta) scutellaris scutellaris* (Stål) : Thirumalai & Sharma, *Zool. Surv. India, Fauna of Melghat Tiger Reserve Conservation Area Series*, 24 : 352.

This is a very widely distributed species in India and mostly found in stagnant pools, pond and ditches. It is the most common member and the largest species (2.8 to 3.1 mm) of the

genus. It can be identified by club shaped tip of the left paramere and grey or greyish brown pronotum of males.

Material examined : 3♂ & 8♀, Shiyal Bet, 4.iii.2003, Reg. No. 542/6, Coll: S. Kumar: all from Nalsarovar Wetland, Gujarat.

Distribution : India (very widely distributed). Africa (Central); China; Indonesia; Malaysia; Saudi Arabia; Srilanka; Vietnam.

9. *Cymatia apparens* (Distant, 1910)

1879. *Corixa hieroglyphica* Distant, *Rhynchota*, 2 : 13. (part)
 1910. *Corixa apparens* Distant, *Fauna Brit. India*, 5 : 343.
 1940. *Cymatia apparens* (Distant) : Hutchinson, *Trans. Connecticut Acad. Art. Sci.*, 33 : 405.
 2000. *Corixa hieroglyphica* Dufour : Ramakrishna, *Rec. Zool. Surv. India*, 98 : 183.
 2002. *Cymatia apparens* (Distant) : Thirumalai & Sharma, *Zool. Surv. India, Wetland Ecosystem Series*, 3 : 108.
 2004. *Cymatia apparens* (Distant) : Thirumalai, *Rec. Zool. Surv. India*, 102(1-2) : 68.

Note : The occurrence of the species reported from Nalsarovar needs further investigation (Anonymous, 1996).

10. *Micronecta (Sigmonecta) quadririgata* Breddin

1905. *Micronecta quadririgata* Breddin, *Soc. Ent. Zurich*, 20 : 57.
 1910. *Micronecta minthe* Distant, *Fauna Brit. India*, 5 : 347.
 1940. *Micronecta (Basileonecta) quadririgata* Breddin : Hutchinson, *Trans. Connecticut Acad. Art. Sci.*, 33 : 376.
 1994. *Micronecta (Sigmonecta) quadririgata* Breddin: Thirumalai, *Misc. Occ. Pap. Rec. zool. Surv. India*, 165 : 8.
 2006. *Micronecta (Sigmonecta) quadririgata* Breddin: Thirumalai & Sureshkumar, *ZSI. Fauna of Biligiri Rangaswamy Temple Wildlife Sanctuary, Conservation Area Series*, 27 : 71.

This species can be identified by the structure of the left paramere and presence of four enlarged bristles at the seventh abdominal tergites of males. The eighth abdominal tergite of the males, which is sigmoid in outline, can also be taken as an identifying character. This is a very common species in Southern and Eastern India.

Material examined : 6♂ & 3♀, Dharabala Bet, 11.xii.2000, Reg. No. 205/6; 1♂, Pan Bet, 7.xii.2000, Reg. No. 159/6, Coll: S. Kumar: all from Nalsarovar Wetland, Gujarat.

Distribution : India (very widely distributed).

Elsewhere : Indonesia; Iran; Malaysia; Philippines; Srilanka.

11. *Anisops campbelli* Brooks

1951. *Anisops campbelli* Brooks, Brooks, *Kans univ. Sci. Bull.*, 34 : 322.
 1964. *Anisops campbelli* Brooks : Lansbury, *Ann. zool. Warszawa*, 22 : 213.

2001. *Anisops campbelli* Brooks : Thirumalai, *Fauna conservation area*, **11** : 117.

2004. *Anisops campbelli* Brooks : Thirumalai, *Rec. zool. Surv. India*, **102**(1-2) : 65.

The interocular space in male projects anteriorly into a very short cephalic horn. The parameres are asymmetrical with the left very deeply excavate on the posterior margin. The ovipositor with two rows of longitudinal teeth and seven tooth-like lateral setae near apex. It is almost entirely confined to the Indian subcontinent.

Material examined : 1 ♂, Shiyal Bet, 4.iii.2003, Reg. No. 542/6, Coll: S. Kumar: all from Nalsarovar Wetland.

Distribution : India; Myanmar

12. *Anisops cavifrons* Brooks

1951. *Anisops cavifrons* Brooks, *Kans. Univ. Sci. Bull.*, **34** : 418.

1994. *Anisops cavifrons* Brooks : Thirumalai, *Misc. Occ. Pap. Rec. Zool. Surv. India*, **165**: 16.

2004. *Anisops cavifrons* Brooks : Thirumalai, *Rec. zool. Surv. India*, **102**(1-2) : 65.

This species is identical to *A. batillifrons* Lundblad in almost every superficial detail and can be distinguished from *A. batillifrons* Lundblad by the presence of a procumbent spine on the fore tibia. In males the left paramere is moderately excavate and there are three closely arranged small setae near the base of tarsus. This species has been reported from both Western Ghats and Eastern Ghats and interestingly recorded from Cochin backwaters in Kerala.

Material examined : 1 ♀, Shiyal Bet, 4.iii.2003, Reg. No. 542/6, 1 ♂, Ranagadh. W. T. Mulbavala, 5.xii.2003, Reg. No. 556/6, Coll: S. Kumar: all from Nalsarovar Wetland, Gujarat.

Distribution : India (widely distributed); Pakistan.

Table 1. Families, habitats, species of Gerromorpha & Nepomorpha associated with water

Family	Habitat	World	India	Gujarat	Nal sarovar
	Infraorder Gerromorpha				
Gerridae	→(water striders) – surface of fresh & brackish waters (sea).	696	79	2	2
Hebridae	→ (velvet water bugs) – marshes & wet riparian mosses Infraorder Nepomorpha	192	15	No report	No report
Hydrometridae	→ (water measurers) – surface of calm waters	125	3	1	No report
Mesoveliidae	→ (water treaders) – vegetated banks of ponds & lakes	46	3	No report	No report

Table 1. Contd.

Family	Habitat	World	India	Gujarat	Nal sarovar
Veliidae	→ (riffle bugs) – surface of ponds & streams, also brackish	876	31	No report	No report
	Infraorder Nepomorpha				
Aphelocheiridae	(bottom bugs) lentic & lotic	63	5	No report	No report
Belostomatidae	(giant water bugs) – ponds, on vegetation	143	6	3	3
Corixidae	(water boatmen) – fresh & brackish lentic waters	552	48	3	3
Gelastocoridae	(toad bugs) – shorelines, in mud & plant debris	103	4	No report	No report
Helotrephidae	(beetle back-swimmers) ponds & lakes, on vegetation	171	13	No report	No report
Naucoridae	(creeping water bugs)–lentic & lotic, stones & vegetation	325	17	No report	No report
Nepidae	(water scorpions) – ponds, on vegetation	230	24	3	1
Notonectidae	(back-swimmers) – ponds and lakes	347	31	2	2
Ochteridae	(shore bugs) – stream margins, pond vegetation	36	1	No report	No report
Pleidae	(pygmy back-wimmers) – ponds & lakes, on vegetation	36	4	No report	No report

DISCUSSION

Information on families, habitats, species of Gerromorpha and Nepomorpha known from World, India, Gujarat and Nalsarovar wetland are provided in the Table 1. The species diversity in an aquatic ecosystem is decided by the topography, altitude, microhabitat richness, monsoon regimes and to certain extent anthropogenic interference (Subramanian *et al*, 2005). To study the functional aspects of community structure incorporated in food web that provides information on energy flow, inventorisation of aquatic insect resources become a priority area (Ananthkrishnan, 1999). The present report of 11 (excluding *Cymatia apparens*) species of aquatic bug from Nalsarovar wetland represent 78.6%, 3.87%, 0.28% of the group so far known from Gujarat, India and the World respectively. Thus, the present study reaffirms the necessity of further intensive systematic exploration of this group from the state and as well from this wetland.

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10.3. Appendix 3. Ichthyofauna

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The Gujarat state holds a large number of saline and freshwater wetlands ranging from small area of few hectares to large Nalsarovar having an area of 23,582 hectares. The freshwater fish fauna of Gujarat is represented by 119 species belongs to 60 genera and 24 families of 8 orders. Of these freshwater fishes, 25 species have been recoded by Sen and Banerjee (2000) for the first time from Gujarat state. The combined diversity of fishes in the state has been assessed to be about 23.8% of total Indian fishes. The fishes of Nalsarovar have being studied by GEER (1998).

The present account is based on collection made by one of the authors¹ from various surveys of Nalsarovar wetland, Gujarat. Species marked with * are recorded for the first time from the wetland. Species marked with + were also reported earlier. Species reported earlier but not found during the present survey has also been listed here making the list of fishes reported from Nalsarovar upto 42. The inventory comprises of 28 species accommodated under 18 genera 5 orders and 10 families. Twenty species marked with asterisk * are reported for the first time from Nalsarovar wetland. Under each species, citation for original description and other accompanying work necessary to undertake the taxon is given. The classification of fishes adopted in this paper is that of Talwar (1971), Patel and Chhaya (1979), Sen (1981, 1994), Talwar and Jhingran (1991), Jayaram (1999) and Menon (1999).

SYSTEMATIC LIST OF FISHES

Class OSTEICHTHYES

I. Order CYPRINIFORMES

(i) Family CYPRINIDAE

Subfamily DANIONINAE

1. **Salmostoma bacaila* (Ham.)
2. **Salmostoma clupeoides* (Bloch.)
3. **Parluciosoma daniconius* (Ham.)

Subfamily CYPRININAE

4. **Puntius sophore* (Ham.)
5. *Puntius sarana sarana* (Ham.)+
6. **Hypselobarbus jerdoni* (Day)
7. *Cirrhinus mrigala* (Ham.)+
8. *Catla catla* (Ham.)+
9. **Labeo bata* (Ham.)

10. *Labeo calbasu* (Ham.)+

11. *Labeo rohita* (Ham.)+

12. **Labeo fimbriatus* (Bloch.)

(ii) Family COBITIDAE

Subfamily COBITINAE

13. **Lepidocephalus guntea* (Ham.)

II. Order SILURIFORMES

(iii) Family BAGRIDAE

Subfamily BAGRINAE

14. **Mystus cavasius* (Ham.)

15. **Mystus montanus* (Jerdon)

16. **Mystus gulio* (Ham.)

(iv) Family SILURIDAE

17. **Ompok pabda* (Ham.)

18. *Wallago attu* (Sch.)+

(v) Family HETEROPNEUSTIDAE

19. *Heteropneustes fossilis* (Bloch.)+

III. Order BELONIFORMES

(vi) Family BELONIDAE

20. **Xenentodon cancila* (Ham.)

IV. Order SYNBRANCHIFORMES

(vii) Family MASTACEMBELIDAE

21. **Macrognathus pancalus* (Ham.)

22. **Macrognathus aculeatus* (Bloch.)

V. Order PERCIFORMES

(viii) Family AMBASSIDAE

23. **Chanda nama* (Ham.)

24. **Pseudambassis ranga* (Ham.)

(ix) Family GOBIIDAE

25. **Glossogobius giuris* (Ham.)

(x) Family CHANNIDAE

26. **Channa orientalis* (Bloch & Sch.)

27. **Channa punctatus* (Bloch.)

28. *Channa striatus* (Bloch.)+

List of species reported earlier but not recorded during the present study

Family CYPRINIDAE

29. *Puntius* sp.
30. *Puntius ticto* (Ham-Buch)
31. *Cirrhinus cirrhosa* (Bloch)
32. *Cyprenus caprio* (Linnaeus)
33. *Garra mullya* (Sykes)

Family BAGRIDAE

34. *Mystus shingala*

Family HETEROPNEUSTIDAE

35. *Saccobranthus* sp. = *Heteropneustes* sp.

Family CHANNIDAE

36. *Channa marulius* (Ham-Buch)
37. *Channa chanos* (Forsskal) (Marine, estuarine)
38. *Ophiocephalus* sp. 1 = *Channa* sp. 1.
39. *Ophiocephalus* sp. 2 = *Channa* sp. 2.

Family CLARIDAE

40. *Clarias* sp.

Family CICHLIDAE

41. *Tilapia mossambica* = *Oreochromis mossambica* (Peters)

Family BELONIDAE

42. *Tylosurus strongylura* = *Strongylura strongylura* (Van Hasselt) (Inhabits coastal water enter estuaries freely).

SYSTEMATIC ACCOUNT

I. Order CYPRINIFORMES

(i) Family CYPRINIDAE

Subfamily Danioninae

1. *Salmostoma bacaila* (Ham.)

1822. *Cyprinus bacaila* Hamilton, *Fish Ganges*, Pp. 265, 384. (Type-locality : Gangetic Provinces).

1999. *Salmostoma bacaila*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Common Name : Large Razor Belly Minnow

Material examined : 1 ex., Nalsarovar (open waters), 29.i.1999; 2 exs., Ranagadh,

19.iii.1999; 3 exs., Nanachera bet, 30.iii.1999; 1 ex., Motachera bet, 9.xii.2000, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Elongated compressed body, long pointed snout, lips thin, lower jaw longer with symphyseal knob. Dorsal fin inserted well in advance of anal fin. Scales very small. Lateral line slightly decurved with 86 to 110 scales. Anal fin with 11-14 branched rays.

Distribution : Northern India to Orissa.

Remarks : It is a surface feeder and is regarded as useful larvivorous fish. Grows to at least 18 cm in length, usually inhabits slow running streams, rivers and ponds.

2. *Salmostoma clupeioides* (Bloch.)

1782. *Cyprinus clupeioides*, Bloch, *Naturl. Aus. Fische.*, 49, pl. 409, fig. 2 (Type locality : Tranque bar)

1999. *Salmostoma clupeioides*, Menon, *Rec. zool. Surv. India Occ*, Paper No., 175 : 366.

Common Name : **Bloch Razor Belly Minnow**

Material examined : 1 ex., Mulbavala, Nalsarovar wetland, 9.ii.1999, coll. S. Kumar.

Diagnostic characters : Body elongate and compressed body, Lateral line scales 74-98 scales. Body without vertical stripes. Number of scales in lateral line and pelvic fin base 3-4.

Distribution : Eastern and Western Ghats, Maharashtra, Madhya Pradesh and Gujarat.

Remarks : It is a food fish and attains a length of 15 cm. It lives in rivers, rivulets and canal; can withstand slight admixture of saline water.

3. *Parluciosoma daniconius* (Ham.)

1822. *Cyprinus daniconius* Hamilton, *Fish Ganges*, P. 327, pl. 15, Fig. 89 (Type locality : Rivers of Southern Bengal).

1999. *Parluciosoma daniconius*, Menon, *Rec. zool. Surv. India, Occ*, Paper No., 175 : 366.

Common name : **Black Line Rasbora**

Material examined : 1 ex., Nalsarovar (open waters), 21.x.2001, coll. S. Kumar.

Diagnostic characters : Body elongate and compressed, pectoral fins shorter than head. Lateral line complete with 31-34 scales. Barbels absent. Origin of dorsal fin nearer to caudal fin base. Anal fin with 7-8 rays. Thick black median band present from eye to caudal fin.

Distribution : Widely Distributed in India.

Remarks : It is a surface feeder. Grows to 10.5 cm in length. Popularly known as 'Rasbora'

Subfamily CYPRININAE

4. *Puntius sophore* (Ham.)

1822. *Cyprinus sophore*, Hamilton, *Fish Ganges*, Pp. 310, 389, P. 19, fig. 86. (Type locality: Ponds and rivers in Gangetic Provinces).

1991. *Puntius sophore*, Jayaram, *Rec. zool. Surv. India, Occ*, Paper No., 135 : 1-178.

Common name : **Stigma Barb**

Material examined : 1 ex., Nanachera bet, 30.iii.1999; 6 exs., Chera bet, 9.xii.2000; 2 exs., Chera bet, 21.ii.2000; 7 exs., Nalsarovar (Open waters), 21.x.2000; 1 ex., Pan bet 7.xii.2000; 2 ex., Dargi, 23.x.2001; 3 exs., Brahmni river, 28.ii.2003, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body short, compressed. Jaws simple, covered by lips, without any knob or tubercle at the symphysis. Barbels absent. Lateral line complete with 23-25 scales. A deep black round blotch at base of caudal fin, a similar blotch on central part of dorsal fin or also on anterior part of body adjacent to dorsal fin.

Distribution : Widely distributed in India.

Remarks : A very plentiful shoaling fish. It attains a length of 13 cm. It is considered of medicinal value in Tamil Nadu. It is very common in ponds of West Bengal.

5. *Puntius sarana sarana* (Ham.)

1822. *Cyprinus sarana*, Hamilton, *Fish Ganges*, Pp. 307, 388. (*Type-locality* : Gangetic system, Bengal).

1999. *Barbodes sarana sarana*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Common Name : Olive barb

Material examined : 1 ex., Chera bet, Nalsarovar wetland, 21.ii.2000, coll. S. Kumar.

Diagnostic characters : Body oblong and fairly deep. Dorsal profile more complex than ventral. Two pairs of barbels. Maxillary pair much longer than orbit. Rostral pair slightly shorter. Lateral line complete with 28-31 scales. Predorsal scales 10; often a golden blotch on the opercle.

Distribution : Krishna and cauvery river systems and Kerala in Peninsular India.

Remarks : Most popular species under this genus of high economic importance all over India, particularly in West Bengal. It grows to about 25 cm in length.

6. *Hypselobarbus jerdoni* (Day)

1870. *Barbus jerdoni*, Day, *Proc. Zool. Soc. Lond.* P. 372 (*Type-locality* : Mangalore, Dakshin Kannada, Karnataka).

1999. *Barbus jerdoni*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Material examined : 1 ex., Devthali, Nalsarovar wetland, 21.x.2001, coll. S. Kumar.

Diagnostic characters : Body fairly deep, its depth 2.7–3 times in standard length. Head 4.2–5 times in standard length. Barbels two pairs; maxillary pair equal to orbit. Rostral pair slightly shorter. Dorsal fin inserted equidistant between tip of snout and base of caudal fin. Scales medium. Lateral line complete with 26–32 scales.

Distribution : Karnataka, Kerala, Tami Nadu, Maharashtra and Gujarat.

Remarks : It inhabits rivers, tributaries and reservoirs etc. Grows to 46 cm in length. Forms important fishery in Karnataka.

7. *Cirrhinus mrigala* (Ham.)

1822. *Cirrhinus mrigala*, Hamilton, *Fish Ganges*, Pp. 297, 389 Pl. 6., fig. 79. (Type-locality : Gangetic Provinces).

1999. *Cirrhinus mrigala*, Menon, *Rec. zool. Surv. India, Occ, Paper No. 175* ; 366.

Common Name : Mrigal

Material examined : 2 ex., Godahut bet, Nalsarovar wetland, 20.x.2001, coll. S. Kumar.

Diagnostic characters : Body streamlined. Its depth equal to length of head. Snout blunt often with pores. Barbels a single short pair of rostral only. Lateral line with 40-45 scales.

Distribution : Northern India from Punjab to West Bengal and Assam.

Remarks : A popular carp of India and noted species largely used for stocking tanks and ponds all over the country, especially in West Bengal. It is introduced in waters of Peninsular India for agriculture. It is detritus eater with a narrow range in food variety. It is a bottom feeder sustaining mainly on decayed vegetation.

8. *Catla catla* (Ham.)

1822. *Cyprinus catla* Hamilton, *Fish Ganges*., Pp. 287, 318, 387; pl. 13, fig. 81. (Type-locality: rivers and tanks of Bengal).

1999. *Catla catla*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Common Name : Catla

Material examined : 2 ex., Devthali, Nalsarovar wetland, 21.x.2001, coll. S. Kumar.

Diagnostic characters : Body deep. Its depth 2,5 to 3 times in standard length. Head enormously large. Mouth wide and upturned, with prominent protruding lower jaw. Lower lip thick. Pectoral fin long, extended to pelvic fin. Lateral line complete with 40 to 43 scales.

Distribution : Widely distributed in Northern India.

Remarks : It is a good food fish. It is one of the renowned and fastest growing Indian major carp. Catla is non-predatory and its feeding is restricted to surface and midwaters. Catla breeds in rivers which are its natural habitats.

9. *Labeo bata* (Ham.)

1822. *Cyprinus bata*, Hamilton, *Fish Ganges*, 283. (Type-locality : Bengal).

1999. *Labeo bata*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Common Name : Bata Labeo

Material examined : 1 ex., Chera bet, Nalsarovar wetland, 21.ii.2000, coll. S. Kumar.

Diagnostic characters : Body elongate, its dorsal profile more convex than the ventral. Snout slightly projecting beyond mouth, often studded with pores. Barbels a pair of minute maxillary only, not easily perceptible. Lateral line with 37 to 40 scales.

Distribution : Peninsular rivers, S. India, Orissa, Madhya Pradesh, Uttar Pradesh, Bihar, West Bengal Bengal, Assam and Maharashtra.

Remarks : It is a tasty minor carp and cultivated with Indian major carps in India. It is widely cultured in 'Bheries' and estuarine waters in Sunderbans (West Bengal). It does not normally breed in ponds, but breeds in rivers during monsoon months.

10. *Labeo calbasu* (Ham.)

1822. *Cyprinus calbasu*, Hamilton, *Fish Ganges.*, Pp. 297, 389, pl. 2, fig. 33. (Type-locality : Bengal).

1999. *Labeo calbasu*, Menon, *Rec. zool. Surv. India, Occ. Paper No.*, 175 : 366.

Common Name : **Black Rohu**

Material examined : 1 ex., Nalsarovar (open waters), 19.x.1999, coll. S. Kumar.

Diagnostic characters : Body stout and rather deep. Head fairly large and conical. Its length less than body depth. Mouth inferior. Lips thick.

Distribution : Widely distributed in India.

Remarks : It is a major carp of India. It is a bottom feeder. It is an important food fish & game fish, can tolerate slightly brackish water.

11. *Labeo rohita* (Ham.)

1822. *Cyprinus rohita*, Hamilton, *Fish Ganges.*, Pp. 301, pl. 36, fig. 85. (Type-locality : Gangetic provinces).

1999. *Labeo rohita*, Menon, *Rec. zool. Surv. India, Occ. Paper No.*, 175 : 366.

Common Name : **Rohu**

Material examined : 2 ex., Devthali, Nalsarovar wetland, 21.x.2001, coll. S. Kumar.

Diagnostic characters : Body moderately elongate, its dorsal profile more ahead than ventral profile. Snout fairly depressed, projects beyond mouth, devoid of lateral lobe. One pair of barbells present. Dorsal fin inserted midway between snout tip and base of caudal fin. Lateral line with 40-42 scales.

Distribution : North and central India.

Remarks : Rohu is a major carp of India, extensively used for stocking tanks though out the country. It is a bottom feeder. Spawning season is generally monsoon. Rohu is regarded as an excellent game fish and seems to put up a better fight in a river than a tank. A number of inter specific and inter generic hybrids have been produced. The most promising inter generic hybrid, male Catla x female Rohu combines the quick growth of Catla and small head of Rohu.

12. *Labeo fimbriatus* (Bloch.)

1797. *Cyprinus fimbriatus*, Bloch, *Ichth. Hist. Nat. Poiss.*; 12 : 50. Pl. 409. (Type-locality : Madras).

1999. *Labeo fimbriatus*, Menon, *Rec. zool. Surv. India, Occ. Paper No.*, 175 : 366.

Common Name : **Fringed-lipped Peninsular Carp**

Material examined : 1 ex., Nalsarovar (open waters), 19.i.1999, coll. S. Kumar.

Diagnostic characters : Body elongate. Dorsal profile convex. Mouth moderate and sub-inferior. Lips thick and fringed, continuous and having an inner fold above and below. Barbels two short pairs. Lateral line with 43-47 scales.

Distribution : West Bengal, Assam, Punjab, Uttar Pradesh, Puna, Madhya Pradesh, Gujarat, South India.

Remarks : A good eating but bony minor carp of India, lives in semi torrential rivers and streams. It is common carp in Tamil Nadu. Pre-dominantly a herbivore, feeding on diatoms, blue-green and green algae, higher aquatic vegetation, insects and decayed organic matter.

(ii) Family COBITIDAE

Subfamily COBITINAE

13. *Lepidocephalus guntea* (Ham.)

1822. *Cobitis guntea*, Hamilton, *Fish Ganges.*, Pp. 353, 394: (Type-locality : Ponds and rivers of Bengal).

1992. *Lepidocephalus guntea*, Menon, *Fauna of India, Pisces*, 4(2) : 54, pl. IV, figs. 1-6, VIII figs, 1 & 2.

Common Name : Loach

Material examined : 1 ex., Brahmni River, Nalsarovar wetland, 28.ii.2003, coll. S. Kumar.

Diagnostic characters : Body elongate, slightly compressed anteriorly and strongly posteriorly. Mouth inferior. Barbels three pairs. Dorsal fin inserted slightly behind the origin of pelvic fins, nearer to caudal fin base than to snout-tip. Scales small, imbricate. Scales on head in patches below and behind eyes and upper part of operculum.

Distribution : Northern India.

Remarks : In young fishes 10-12 blotches present on body. In adults blotches fuse to form continuous dark lateral band. Dorsal and caudal fins with rows of dark spots. It is of no interest to fisheries but of interest as an aquarium fish.

II. Order SILURIFORMES

(iii) Family BAGRIDAE

Subfamily BAGRINAE

14. *Mystus cavasius* (Ham.)

1822. *Pimelodus cavasius*, Hamilton, *Fish Ganges.* Pp. 203 , 397; P II, fig. 67. (Type-locality: Gangetic provinces).

1999. *Mystus cavasius*, Jayaram, *HBFW Fish India*, p. 199.

Common Name : Gangetic Mystus

Material examined : 2 ex., Pan bet, Nalsarovar wetland, 7.xii.2000, coll. S. Kumar.

Diagnostic characters : Body elongate and compressed; its depth 4-4.5 times in standard length. Barbels 4 pairs. Maxillary barbells extend posteriorly beyond caudal fin base in adults. Dorsal spine weak, often feebly serrated. Adipose fin large, inserted close behind with base of rayed dorsal fin. A dark shoulder spot at the anterior base of dorsal fin.

Distribution : Widely distributed in India.

Remarks : Greyish, mid lateral longitudinal stripes present on body. It's pectoral spine causes painful wounds. This catfish is very common food fish in Indian region.

15. *Mystus montanus* (Jerdon)

1849. *Bagras montanu* Jerdon, *Madras J. Lit. Sci.*, 15 : 37, 1849 (Type-locality : Manantoddy, Wynaad).

1999. *Mystus montanus*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Material examined : 1 ex., Shiyal bet, Nalsarovar wetland, 16.ii.2000, coll. S. Kumar.

Diagnostic characters : Body elongate and compressed, its depth about 5 times in standard length. Head depressed. Occipital process narrow. Upper jaw slightly longer, median longitudinal groove extends to midway, between eye and base of occipital process. Pectoral spine strong. A bluish spot on shoulder and a dark spot at caudal base. One or two light bands along the side above lateral line.

Distribution : South India, Madhya Pradesh and Gujarat.

Remarks : Grows 12-15 cm in length, is of minor interest to fisheries.

16. *Mystus gulio* (Ham.)

1822. *Pimelodus gulio* Hamilton, *Fish Ganges.*, Pp. 201, 379, pl. 23, fig. 66. (Type-locality : Higher parts of Gangetic Estuaries).

1999. *Mystus gulio*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Material examined : 1 ex., Nanachera bet, 30.iii.1999; 2 exs., Nalsarovar (open waters), 21.x.2001, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body elongate. Depth 3.8 to 4.1 times in SL. Head depressed; its upper surface rough and granulated. Occipital process triangular, medium longitudinal groove on head short. Barbels 4 pairs. Maxillary barbells extend posteriorly to end of pelvic fins.

Distribution : Widely distributed in India.

Remarks : This gregarious catfish which is partly marine, is a very common species in fishery catches in Gangetic Estuary, Chilka lake (Orissa) and Kerala. It inhabits estuaries, tidal rivers and lakes, ascending to freshwater, often enters the sea.

(iv) Family SILURIDAE

17. *Ompok pabda* (Ham.)

1822. *Silurus pabda* Hamilton, *Fish Ganges.*, Pp. 150, 374, pl. 25, fig. 47. (Type-locality : Bengal).

1999. *Ompok pabda*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Common Name : Indian Butter Cat fish

Material examined : 1 ex., Nalsarovar (Open waters), 19.i.1999, coll. S. Kumar.

Diagnostic characters : Body elongate, mouth large and oblique. Teeth in villiform, bands

on jaws. Barbels two pairs. Maxillary pair extend usually to as far as middle of pectoral fin. The mandibular barbells extend to posterior border of eye. Anal fin long, inserted usually opposite to dorsal fin. Pectoral spine moderately strong, serrated on its inner edge in males, often feeble in females. Two dark lateral bands on body, a dark oval shoulder spot on lateral line.

Distribution : North-eastern states of India.

Remarks : This species which attains a length of 17 cm is caught in fairly large numbers in West Bengal. It is an esteemed food fish. It is also known for its butter like taste.

18. *Wallago attu* (Sch.)

1801. *Silurus attu*, Schenider, *Sdyst. Ichth.*, p. 378; pl. 75 (Type-locality : Malabar).

1981. *Wallago attu*, Jayaram, *HBFW Fish India*, p. 210.

Common Name : **Boal**

Material examined : 1 ex., Devthali, Nalsarovar wetland, 21.x.2001, coll. S. Kumar. ..

Diagnostic characters : Body elongate, length of head 5 to 5.5 in total length; large depressed head, snout spatulate, mouth wide, its gap extends posteriorly to beyond eyes. Barbels two pairs. Maxillary pair long, extend beyond the origin of anal fin. The mandibular much shorter, dorsal fin short, inserted slightly in advance of pelvic fins. Weak pectoral fin. A faint orange-yellow band along lateral line often present.

Distribution : Widely distributed in India.

Remarks : It is one of the largest, voracious and predatory catfish, inhabiting large rivers, tanks and lakes. The fish prefers muddy tank subject to periodical flooding from a nullah or river. It is a pre-monsoon or a summer breeder. It is very destructive to other more valuable food-fishes such as major carps. It grows to about 2 m and weighs more than 45 kg. Due to its rich content it is liked by many, particularly in Bihar.

(v) Family HETEROPNEUSTIDAE

17. *Heteropneustes fossilis* (Bloch.)

1798. *Silurus fossilis* Bloch, *Ichth. Hist. Nat. Poiss*; 11: 36. 370, fig. 2. (Type-locality: Bengal).

1981. *Heteropneustes fossilis*, Jayaram, *HBFW Fish India*, : 475.

Common Name : **Stinging Catfish**

Material examined : 3 exs., Chera bet, 9.xii.2000; 2 exs., Godahut bet, 20.x.2001, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body elongate, sub-cylindrical to pelvics. Eyes small, wide flat head. 4 pairs of barbells. Maxillary pair extending to middle of pectoral or to pelvic base. Wide gill opening, gill cavity with an accessory respiratory apparatus. Pectorals not reaching pelvic. Pectoral with a strong serrated semi-poisonous spine which may cause serious pain if wounded by it on the fingers of holder. Dark purplish brown with two yellowish lateral line bands in juveniles.

Distribution : Widely distributed in India.

Remarks : Grows to 30 cm, highly esteemed for its nourishing vigor and good taste. Live in freshwaters as well as brackish waters. The fish is of medicinal value.

III. Order BELONIFORMES

(vi) Family BELONIDAE

20. *Xenentodon cancila* (Ham.)

1822. *Esox cancila* Hamilton, *Fish Ganges*, 213, 215, 380; pl. 27, fig. 70. (Type-locality : Gangetic provinces).

1999. *Xenentodon cancila*, Menon, *Rec. zool. Surv. India, Occ. Paper No.*, 175 : 366. (Checklist).

Common Name : **Freshwater Garfish**

Material examined : 1 ex., Sur bet, 28.iii.1999; 1 ex., Chera bet, 9.xii.2000; 2 exs., Mulbavala, 19.ii.2000, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body very elongate, sub-cylindrical compressed. Dorsal fin and anal fin about equal and inserted in opposite position. Caudal fin truncate. Snout sharply pointed. Jaws prolonged in to beak.

Distribution : Widely distributed in India.

Remarks : It is a surface living fish, attain length of 30 cm. It is a larvivorous and good aquarium fish.

IV. Order SYNBRANCHIFORMES

(vii) Family MASTACEMBELIDAE

21. *Macrogathus pancalus* (Ham.)

1822. *Macrogathus pancalus* Hamilton, *Fish Ganges*, 30, 364, pl. 223, fig. 7. (Type-locality : Bengal).

1999. *Mastacembelus pancalus*, Yazdani, *Rec. Zol. Surv. India, Occ. Paper No.*, 124 : 1-26.

Common Name : **Spiny Eel**

Material examined : 2 exs., Nalsarovar (open waters), 21.x.2001; 1 ex., Pan bet, 15.ii.2000; 1 ex., Sur bet, 28.iii.1999, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Cylindrical, eel shaped, elongated body. Cleft of mouth narrow, a long fleshy snout with a trilobed extremity. First dorsal with free spine. The soft dorsal and anal are separated from caudal by a small notch. No pelvic fins. Fins yellowish to black spots. White spots on the body. One strong pre-orbital spine and 2-5 spines on preoperculum present.

Distribution : Widely distributed in India.

Remarks : Inhabits rivers and estuaries. Round, white spots or brown, vertical stripes present on body. Grows to 18 cm in length. Generally prefers slow and sluggish waters. Commercially less important.

22. *Macragnathus aral* (Bloch & Sch.)

1822. *Macragnathus aculeatus* Hamilton, *Fish Ganges*, pl. 29 (Type-locality : Gangetic Provinces).

1999. *Macragnathus aral* Menon, *Rec. zool. Surv. India, Occ. Paper No.*, 175 : 366.

Material examined : 1 ex., Ranagadh, Nalsarovar wetland, 7.xii.2000, coll. S. Kumar.

Diagnostic characters : Eel shaped fish with tapering head and tail. Narrow cleft of mouth. Distinct lateral line. Elongated fleshy snout. Lower jaw much shortened. A single dorsal with 16-20 free spines. Caudal not united with dorsal and anal fins. Anal fin with three spines. Smaller ones with 4-9 large black ocelli at the base of dorsal.

Distribution : Widely distributed in India.

Remarks : Inhabits slow and shallow waters. Grows to 38 cm in length. Very little commercial importance.

V. Order PERCIFORMES

(viii) Family AMBASSIDAE

23. *Chanda nama* (Ham.)

1822. *Chanda nama*, Hamilton, *Fish Ganges.*, 109; 371, pl. 39, fig. 37. (Type-locality : N.E. Bengal).

1999. *Chanda nama*, Menon, *Rec. zool. Surv. India, Occ. Paper No.*, 175 : 366.

Common Name : Elongate Glass Perchlet

Material examined : 1 ex., Sur bet, 28.iii.1999; 1 ex., Ranagadh, 29.iii.1999; 1 ex., Basori bet, 16.x.2001, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body ovate and strongly compressed. Mouth large with prominent lower jaw. Teeth villiform on jaws with three canines on either side of lower jaw. Scales minute, often irregularly arranged. Lateral line with 100 – 107 scales. A dark blotch on dorsal fin upper edge generally present. A forwardly directed procumbent spine present in the dorsal fin.

Distribution : Widely distributed in India.

Remarks : Commercially known as 'Glass fish', used in aquariums. Inhabits fresh and brackish waters. It attains a length of 11 cm. This species could effectively be used in control of guinea worms and also for malaria control. These small bony fishes are not commercially important due to strong spines and scanty flesh.

24. *Pseudambassis ranga* (Ham.)

1822. *Chanda ranga*, Hamilton, *Fish Ganges*; 113, 371, pl. 6. Fig. 38. (Type-locality : Gangetic provinces).

1991. *Pseudambassis ranga*, Talwar & Jhingran, *Inland fisheries*, 2 : 805.

Common Name : Indian Glassy Fish

Material examined : 1 ex., Vekaria (shore area near village side), 26.iii.1999; 1 ex., Chera bet. 9.xii.2000, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body stout, deep and compressed. Preopercular hind edge smooth with one or two serrations at angle. Lateral line with 47-63 scales. A dorsal shoulder spot present.

Distribution : Widely distributed in India.

Remarks : It is a good aquarium fish. It makes nest and guard its young. It attains a maximum length of 7 cm. It is a monsoon breeder. Three small sized fish is found in fish market with other small fishes.

(ix) Family GOBIIDAE

25. *Glossogobius giuris* (Hamilton)

1822. *Gobius giuris* Hamilton, *Fish Ganges.*, Pp. 51, 306.

1999. *Glossogobius giuris*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Common Name : Tank goby

Material examined : 2 exs., Nanachera bet, 30.iii.1999; 3 exs., Chera bet, 9.xii.2000; 1 ex., Pan bet, 7.xii.2000; 1 ex., Chera bet, 21.2.2000; 2 ex., Nalsarovar (open waters), 21.x.2001; 1 ex., Shiyal bet, 16.ii.2000, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body elongate and somewhat compressed. A long tapering fish with vertically compressed head, lower jaw prominent. Two dorsals placed closely, pelvics united forming a disk, olive to lighter green above lighter below. 4 to 6 black blotches on body along the lateral line. Dorsal, pectoral and caudal fins mottled with dark spots. Spots darkest along spine of second dorsal fin.

Distribution : Widely distributed in India.

Remarks : Commercially not important. It is tasteless fish, but it is a beautiful aquarium fish. It attains a length of about 30 cm.

(x) Family CHANNIDAE

26. *Channa orientalis* (Bloch & Sch.)

1801. *Channa orientalis* Bloch. and Schneider, *Syst. Ichth.* P. 496, pl. 90, fig. 2. (Type-locality : India).

1999. *Channa orientalis*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Common Name : Asiatic snakehead

Material examined : 13 exs., Nalsarovar (open waters), 19.i.1999; 1 ex., Vekaria (village side), 26.iii.1999, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body elongate and fairly rounded in cross section. Pectoral fins extend to anal fins, pelvic fin less than 50% of pectoral fin length. Caudal fin rounded. Scales on summit of head large rosette of head-scale situated behind orbit so that it touches frontal head – scale in front and basal head-scale behind. Pre-dorsal scales 12. Base of pectoral fin with transverse black bands.

Distribution : Widely distributed in India.

Remarks : This species is smallest member of genus attains 20-21 cm in length. This species includes forms with and without pelvic fins, the later being known from Sri Lanka, Myanmar and Java. *Channa gachua* is synonym of this species (Menon, 1974).

27. *Channa punctatus* (Bloch.)

1794. *Ophiocephalus punctatus* Bloch. *Natur Aus. Fische*, 7 : 139, pl. 358. (Type-locality : Coromandal coast).

1999. *Channa punctatus*, Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175 : 366.

Common Name : **Spotted Snakehead.**

Material examined : 11 ex., Sur bet, 28.iii.1999; 1 ex., Ranagadh, 28.iii.1999; 2 exs., Nanachera bet, 30.iii.1999; 3 exs., Nalsarovar (open waters), 21.x.1999; 1 ex., Mulbavala, 19.ii.2000; 1 ex., Chera bet, 21.ii.2000; 6 ex., Godahut bet, 20.x.2001, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body elongate. Pectoral fin extend to anal fin. Pelvic fin is about 75% of pectoral fin length. Caudal fin rounded. Pre-dorsal scales 12. Scales 37-40 in lateral series. Several short cross bands descending from back

Distribution : Widely distributed in India.

Remarks : It is a medium to large sized fish, inhabiting ponds, irrigation canal, paddy fields (during monsoon seasons), tanks etc., Prolific breeder, breeds in ponds through out year by forming nest. Peak breeding is before and during monsoon.

28. *Channa striatus* (Bloch.)

1791. *Ophiocephalus striatus* Hamilton, *Natur Aus. Fische*, 2 : 141, pl. 359. (Type-locality : Malbar).

1999. *Channa striatus* Menon, *Rec. zool. Surv. India, Occ, Paper No.*, 175: 366.

Common Name : **Striper or Banded Snakehead**

Material examined : 2 exs., Nalsarovar (Shore area), 12.iii.2000; 1 ex., Limsi bet, 16.xii.2000; 1 ex., Chera bet, 9.xii.2000, coll. S. Kumar: all from Nalsarovar wetland, Gujarat.

Diagnostic characters : Body elongate and fairly rounded in cross section. Pectoral fin is about two times in head length. Caudal fin rounded. Pre-dorsal scales 18-20. Scales 50-57 in lateral series. 9 rows of scales between eye and angle of opercle. Patchy greyish bands descends from side to abdominal region.

Distribution : Widely distributed in India.

Remarks : This species is most widely distributed and economically the most important member of genus. It attains a length of 60-75 cm in widely distributed and high priced fish. Flesh is firm, white, practically boneless and of most agreeable flavor. It tolerates slightly brackish water.

DISCUSSION

The ichthyofauna of Nalsarovar is dominated by 13 cyprinid and cobitid species (Order: Cypriniformes) followed by 6 species of perches (Perciformes) and 8 species of other orders, similar studies in other freshwater rivers and wetlands of India revealed the occurrence 18 species belonging to 2 families and 2 orders from Giriganga river, Uttarkhand (Joshi *et al.*, 1993) 30 species belonging to 9 families and 6 orders from Kaveri river, Tamilnadu (Madhyastha and Murugan, 1996), 34 species belonging to 9 families and 5 orders from different freshwater bodies of Wynad district Kerala (Raghunathan, 1993), 79 species belonging to 19 families and 6 orders from Damodar river, Bihar (Sarkar and Banerjee, 2000), 116 species belonging to 46 genera and 20 families from Niligiri Biosphere Reserve (Yazdani *et al.*, 2001).

In recent times fishes, especially freshwater fishes of the Indian Region, are threatened due to loss of habitat, as rivers are being dammed or diverted and wetlands are cleared for agriculture and for other purposes Jayaram (1949), Jayaram (1949) and Barman (1993). Deleterious effects also result from over fishing, catching of breeding fish and fry, pollution of rivers and streams.

Zoo geographically Gujarat fishes show more affinities with that of central India. *i.e.*, the Satpura and Narmada drainage system than to peninsula and specially Western Ghats. The noteworthy feature of fishes of Nalsarovar is that they show close affinity to fishes of Rajasthan, Punjab and Western Himalaya. In order to protect fish fauna, conservation steps like ban on mass killing, preventing collection of fry, fingerlings and broods, enforcement of new fishery law must be taken.

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10.4. Appendix 4. Reed dwelling avian species at Nalsarovar

FALCONIFORMES

PANDIONIDAE : OSPREY

1. Osprey, *Pandion haliaetus* (Linnaeus, 1758) +

FALCONIDAE : FALCONS

2. Peregrine Falcon, *Falco peregrinus* Tunstall, 1771*

GALLIFORMES

PHASIANIDAE : PARTRIDGES

3. Swamp Francolin, *Francolinus gularis* (Temminck, 1815)*

STRIGIFORMES

STRIGIDAE : OWLS

4. Tawny Fish-Owl, *Ketupa flavipes* (Hodgson, 1836)*

CORACIIFORMES

MEROPIDAE : BEE-EATERS

5. Blue-cheeked Bee-eater, *Merops persicus* Pallas, 1773 +

6. Blue-tailed Bee-eater, *Merops philippinus* Linnaeus, 1766 +

PASSERIFORMES

HIRUNDINIDAE : SWALLOWS & MARTINS

7. Common Swallow, *Hirundo rustica* Linnaeus, 1758 +

8. Wire-tailed Swallow, *Hirundo smithii* Leach, 1818 +

9. Red-rumped Swallow, *Hirundo daurica* Linnaeus, 1771 +

MOTACILLIDAE : WAGTAILS & PIPITS

10. White Wagtail, *Motacilla alba* Linnaeus, 1758 +

11. Large Pied Wagtail, *Motacilla maderaspatensis* Gmelin, 1789 +

12. Citrine Wagtail, *Motacilla citreola* Pallas, 1776*

13. Yellow Wagtail, *Motacilla flava* Linnaeus, 1758 +

14. Water Pipit, *Anthus spinoletta* (Linnaeus, 1758)*

MUSCICAPIDAE

TURDINAE : THRUSHES, SHORTWINGS, ROBINS & FORKTAILS

15. Guldenstadt's Redstart, *Phoenicurus erythrogaster* (Guldenstadt, 1775)*

16. White-capped Redstart, *Chaimarrornis leucocephalus* (Vigors, 1831)*

17. Plumbeous Redstart, *Rhyacornis fuliginosus* (Vigors, 1831)*
18. Little Forktail, *Enicurus scouleri* Vigors, 1832*
19. Black-backed Forktail, *Enicurus immaculatus* (Hodgson, 1836)*
20. Slaty-backed Forktail, *Enicurus schistaceus* (Hodgson, 1836)*
21. Leschenault's Forktail, *Enicurus leschenaulti* (Vieillot, 1818)*
22. Spotted Forktail, *Enicurus maculatus* Vigors, 1831*
23. White-tailed Stonechat, *Saxicola leucura* (Blyth, 1847)*

TIMALIINAE : BABBLERS

24. Marsh Babbler, *Pellorneum palustre* Gould, 1872*
25. Jerdon's Babbler *Chrysomma altirostre* Jerdon, 1862*

SYLVIINAE : PRINIAS & WARBLERS

26. Long-tailed Prinia, *Prinia burnesii* (Blyth, 1844)*
27. Rufous-rumped Grass-Warbler, *Graminicola bengalensis* Jerdon, 1863*

10.5 Appendix 5. Passerine birds in and around the Nalsarovar wetland

FALCONIFORMES

ACCIPITRIDAE: HAWKS, EAGLES, BUZZARDS, KITES, HARRIERS

1. Black-shouldered Kite, *Elanus caeruleus* (Desfontaines, 1789) +
2. Black Kite, *Milvus migrans* (Boddaert, 1783) +
3. Egyptian Vulture, *Neophron percnopterus* (Linnaeus, 1758) +
4. Whitebacked Vulture, *Gyps bengalensis* (Gmelin, 1788) +
5. Long-billed Vulture, *Gyps indicus* (Scopoli, 1786) -
6. Red-headed Vulture, *Sarcogyps calvus* (Scopoli, 1786) -
7. Montagu's Harrier, *Circus pygargus* (Linnaeus, 1758)*
8. Shikra, *Accipiter badius* (Gmelin, 1788)*
9. Black Eagle, *Ictinaetus malayensis* (Temminck, 1822)*

FALCONIDAE : FALCONS

10. Lesser Kestrel, *Falco naumanni* Fleischer, 1818 -
11. Common Kestrel, *Falco tinnunculus* Linnaeus, 1758 +

GALLIFORMES

PHASIANIDAE : PHEASANTS, PARTRIDGES, QUAILS

12. Painted Francolin, *Francolinus pictus* (Jardine & Selby, 1828) +

13. Grey Francolin, *Francolinus pondicerianus* (Gmelin, 1789) +
14. Common Quail, *Coturnix coturnix* (Linnaeus, 1758) +
15. Rain Quail, *Coturnix coromandelica* (Gmelin, 1789)*
16. Indian Peafowl, *Pavo cristatus* (Linnaeus, 1758) +

CHARADRIIFORMES

GLAREOLIDAE : COURSERS & PRATINCOLES

17. Indian Courser, *Cursorius coromandelicus* (Gmelin, 1789) +

COLUMBIFORMES

PTEROCLIDIDAE : SANDGROUSE

18. Chestnut-bellied Sandgrouse, *Pterocles exustus* Temminck, 1825 +
19. Spotted Sandgrouse, *Pterocles senegallus* (Linnaeus, 1771) +
20. Painted Sandgrouse, *Pterocles indicus* (Gmelin, 1789)+

COLUMBIDAE : PIGEONS & DOVES

21. Blue Rock Pigeon, *Columba livia* Gmelin, 1789 +
22. Little Brown Dove, *Streptopelia senegalensis* (Linnaeus, 1766) +
23. Spotted Dove, *Streptopelia chinensis* (Scopoli, 1786) +
24. Red Collared-Dove, *Streptopelia tranquebarica* (Hermann, 1804) +
25. Eurasian Collared-Dove, *Streptopelia decaocto* (Frisvaldszky, 1838) +

PSITTACIFORMES

PSITTACIDAE : PARAKEETS & HANGING-PARROTS

26. Rose-ringed Parakeet, *Psittacula krameri* (Scopoli, 1769) +
27. Plum-headed Parakeet, *Psittacula cyanocephala* (Linnaeus, 1766)-

CUCULIFORMES

CUCULIDAE : CUCKOOS, MALKHOHAS & COUCALS

28. Pied Crested Cuckoo, *Clamator jacobinus* (Boddaert, 1783) +
29. Brainfever Bird, *Hierococcyx varius* (Vahl, 1797)*
30. Asian Koel, *Eudynamys scolopacea* (Linnaeus, 1758) +
31. Greater Coucal, *Centropus sinensis* (Stephens, 1815) +

STRIGIFORMES

STRIGIDAE : OWLS

32. Eurasian Eagle Owl, *Bubo bubo* (Linnaeus, 1758) -
33. Spotted Owlet, *Athene brama* (Temminck, 1821) +

CAPRIMULGIFORMES

CAPRIMULGIDAE : NIGHTJARS

34. Common Indian Nightjar, *Caprimulgus asiaticus* Latham, 1790*
 35. Franklin's Nightjar, *Caprimulgus affinis* Horsfield, 1821 -

APODIFORMES

APODIDAE : SWIFTS

36. House Swift, *Apus affinis* (J. E. Gray, 1830) +
 37. Alpine Swift, *Tachymarptis melba* (Linnaeus, 1758) -

CORACIIFORMES

MEROPIIDAE : BEE-EATERS

38. Small Bee-eater, *Merops orientalis* Latham, 1801 +

CORACIIDAE : ROLLERS

39. Indian Roller, *Coracias benghalensis* (Linnaeus, 1758) +
 40. European Roller, *Coracias garrulus* Linnaeus, 1758 +

UPUPIDAE : HOOPOES

41. Common Hoopoe, *Upupa epops* Linnaeus, 1758 +

PICIFORMES

CAPITONIDAE : BARBETS

42. Coppermith breasted Barbet, *Megalaima heamacephala* (P.L.S. Müller, 1776)+

PICIDAE : WOODPECKERS

43. Yellow-fronted Pied wood Pecker, *Dendrocopos mahrattensis* (Latham, 1801)+
 44. Lesser Golden-backed Woodpecker, *Dinopium benghalense* (Linnaeus, 1758)*

PASSERIFORMES

ALAUDIDAE : LARKS

45. Singing Bush-Lark, *Mirafra cantillans* Blyth, 1845 +
 46. Blackcrowned Sparrow-Lark, *Eremopterix nigriceps* (Gould, 1839) +
 47. Common Crested Lark, *Galerida cristata* (Linnaeus, 1758) +
 48. Syke's Crested Lark, *Galerida deva* (Sykes, 1832) +

HIRUNDINIDAE : SWALLOWS & MARTINS

49. Dusky Crag-Martin, *Hirundo concolor* Sykes, 1833 +

MOTACILLIDAE : WAGTAILS & PIPITS

50. Eurasian Tree Pipit, *Anthus trivialis* (Linnaeus, 1758) +

CAMPEPHAGIDAE : MINIVETS

51. Large Cuckoo-Shrike, *Coracina macei* (Lesson, 1830) -
 52. Small Minivet, *Pericrocotus cinnamomeus* (Linnaeus, 1766) +

PYCNONOTIDAE : BULBULS, FINCHES

53. Himalayan White cheeked Bulbul, *Pycnonotus leucogenys* (Gray, 1835) +
 54. Red-whiskered Bulbul, *Pycononotus jocosus* (Linnaeus, 1758)*
 55. Red-vented Bulbul, *Pycnonotus cafer* (Linnaeus, 1766) +

IRENIDAE : CHLOROPSIS

56. Common Iora, *Aegithina tiphia* (Linnaeus, 1758) -
 57. Gold-fronted Chloropsis, *Chloropsis aurifrons* (Temminck, 1829)*

LANIIDAE : SHRIKES

58. Brown Shrike, *Lanius cristatus* Linnaeus, 1758 -
 59. Bay-backed Shrike, *Lanius vittatus* Valenciennes, 1826 -
 60. Rufous-backed Shrike, *Lanius schach* Linnaeus, 1758 +
 61. Great Grey Shrike, *Lanius excubitor* Linnaeus, 1758 +

MUSCICAPIDAE :

TURDINAE : ROBINS, WHEATERS & TURDINAE

62. Bluethroat, *Luscinia svecica* (Linnaeus, 1758) -
 63. Oriental Magpie Robin, *Copsychus saularis* (Linnaeus, 1758) +
 64. Indian Robin, *Saxicoloides fulicata* (Linnaeus, 1776) +
 65. Black Redstart, *Phoenicurus ochruros* (Gmelin, 1774) +
 66. Common Stonechat, *Saxicola torquata* (Linnaeus, 1766) +
 67. Pied Bushchat, *Saxicola caprata* (Linnaeus, 1766) -
 68. Pied Chat, *Oenanthe picata* (Blyth, 1847) -
 69. Desert Wheater, *Oenanthe deserti* (Temminck, 1825) -
 70. Indian Chat, *Cercomela fusca* (Blyth, 1851) -

TIMALIINAE: BABBLERS

71. Yellow-eyed Babbler, *Chrysomma sinense* (Gmelin, 1789) +
 72. Common Babbler, *Turdoides caudatus* (Dumont, 1823) +
 73. Large Grey Babbler, *Turdoides malcolmi* (Sykes, 1832) +
 74. Jungle Babbler, *Turdoides striatus* (Dumont, 1823) +

SYLVIINAE: WARBLERS & PRINIAS

- 75. Rufosfronted Wren-Warbler, *Prinia buchanani* Blyth, 1844*
- 76. Franklin's Prinia, *Prinia hodgsonii* Blyth, 1844 -
- 77. Graceful Prinia, *Prinia gracilis* (Lichtenstein, 1823) +
- 78. Ashy Prinia, *Prinia socialis* Sykes, 1832 +
- 79. Plain Prinia, *Prinia inornata* Sykes, 1832 +
- 80. Blyth's Reed-Warbler, *Acrocephalus dumetorum* Blyth, 1849*
- 81. Great Indian Reed Warbler, *Acrocephalus stentoreus* (Hemprich & Ehrenberg, 1833)*
- 82. Common Tailor Bird, *Orthotomus sutorius* (Pennant, 1769) +

MUSCICAPINAE : FLYCATCHERS

- 83. Asian Brown Flycatcher, *Muscicapa dauurica* Pallas, 1811 -
- 84. Red-throated flycatcher, *Ficedula parva* (Bechstein, 1792) -
- 85. Tickell's Blue-Flycatcher, *Cyornis tickelliae* Blyth, 1843 +

RHIPIDURINAE : FAINTAIL-FLYCATCHERS

- 86. White browed Fantail Flycatcher, *Rhipidura aureola* Lesson, 1830*

NECTARINIIDAE : SUNBIRDS

- 87. Purple Sunbird, *Nectarinia asiatica* (Latham, 1790) +

ZOSTEROPIDAE : WHITE-EYES

- 88. Oriental White-eye, *Zosterops palpebrosus* (Temminck, 1824) -

ESTRILDIDAE : MUNIAS

- 89. White-throated Munia, *Lonchura malabarica* (Linnaeus, 1758) +
- 90. Black-throated Munia, *Lonchura kelaarti* (Jerdon, 1863) +
- 91. Spotted Munia, *Lonchura punctulata* (Linnaeus, 1758) -
- 92. Black-headed Munia, *Lonchura malacca* (Linnaeus, 1766)*

PASSERIDAE : SPARROWS & WEAVERS

PASSERINAE : SPARROWS

- 93. House Sparrow, *Passer domesticus* (Linnaeus, 1758) +

PLOCEINAE : WEAVERS

- 94. Baya Weaver, *Ploceus philippinus* (Linnaeus, 1766) +

STURNIDAE : MYNAS & STARLINGS

- 95. Bank Myna, *Acridotheres ginginianus* (Latham, 1790) +
- 96. Indian Common Myna, *Acridotheres tristis* (Linnaeus, 1766) +

97. Brahminy Starling, *Sturnus pagodarum* (Gmelin, 1789) +

98. Rosy Starling, *Sturnus roseus* (Linnaeus, 1758) +

ORIOLIDAE : ORIOLES

99. Eurasian Golden Oriole, *Oriolus oriolus* (Linnaeus, 1758) -

DICRURIDAE : DRONGOS

100. Black Drongo, *Dicrurus macrocercus* Vieillot, 1817 +

101. White-bellied Drongo, *Dicrurus caerulescens* (Linnaeus, 1758) -

CORVIDAE : CROWS

102. Indian Tree Pie, *Dendrocitta vagabunda* (Latham, 1790) -

103. House Crow, *Corvus splendens* Vieillot, 1817 +

104. Jungle Crow, *Corvus macrorhynchos* Wagler, 1827 +

10.6. Appendix 6. Mammalian Species

SYSTEMATIC LIST

Order INSECTIVORA

Family SORICIDAE

Subfamily CROCIDURINAE

1. *Suncus murinus* (Linnaeus, 1766) House Shrew

2. **Suncus etruscus* (Savi,) Pygmy White-toothed Shrew **

Order CHIROPTERA

Suborder MEGACHIROPTERA

Family PTEROPODIDAE

Subfamily PTEROPODINAE

3. **Cynopterus sphinx* (Vahl, 1797) Short-nosed Fruit Bat

Family VESPERTILIONIDAE

4. **Pipistrellus ceylonicus* (Kelaart, 1852) Kelaart's Pipistrelle

Order PRIMATES

Family CERCOPITHECIDAE

Subfamily COLOBINAE

5. **Semnopithecus entellus* (Dufresne, 1797) Hanuman Langur

Order CARNIVORA

Family CANIDAE

6. *Canis aureus* Linnaeus, 1758 Asiatic Jackal

7. **Canis lupus* Linnaeus, 1758 Wolf
8. *Vulpes bengalensis* (Shaw, 1800) Indian Fox
Family HYAENIDAE
9. *Hyaena hyaena* (Linnaeus, 1758) Striped Hyaena
Family FELIDAE
Subfamily FELINAE
10. *Felis chaus* Schreber, 1777 Jungle Cat
Family HERPESTIDAE
Subfamily HERPESTINAE
11. *Herpestes edwardsii* (E. Geoffrey Saint-Hilaire, 1818) Indian Gray Mongoose
Family VIVERRIDAE
Subfamily PARADOXURINAE
12. **Paradoxurus hermaphroditus* (Pallas, 1777) Toddy Cat
13. **Viverricula indica* (Desmarest, 1804) Small Indian Civet
Order PERISSODACTYLA
Family EQUIDAE
14. *Equus onager* Boddaert, 1785 Indian Wild Ass
Order ARTIODACTYLA
Family SUIDAE
Subfamily SUINAE
15. *Sus scrofa* Linnaeus, 1758 Indian Wild Boar
Family BOVIDAE
Subfamily ANTILOPINAE
16. *Antilope cervicapra* (Linnaeus, 1758) Black Buck
Subfamily BOVINAE
17. *Boselaphus tragocamelus* (Pallas 1766) Blue Bull
RODENTIA
SCIUROGNATHI
SCIURIDAE
SCIURINAE
18. *Funambulus pennantii* Wroughton, 1905 Northern Palm Squirrel

Family MURIDAE

Subfamily GERBILLINAE

19. *Meriones hurrianae* (Jordon, 1867) Indian Desert Gerbil

20. *Tatera indica* (Hardwicke, 1807) Indian Gerbil

Subfamily MURINAE

21. **Bandicota bengalensis bengalensis* (Gray,1835) Lesser Bandicoot Rat

22. **Bandicota indica indica* (Bechestein, 1800) Large Bandicoot Rat

23. **Mus musculus* Linnaeus, 1758 House Mouse

24. **Rattus rattus alexandrinus* (Desmarest) House Rat

Order LAGOMORPHA

Family LEPORIDAE Fischer, 1817

25: *Lepus nigricollis* Cuvier, 1823 Indian Hare or Black-napped Hare



Durgi village inhabited by Padhan tribe community in the vicinity of Nal Sarovar Wetland



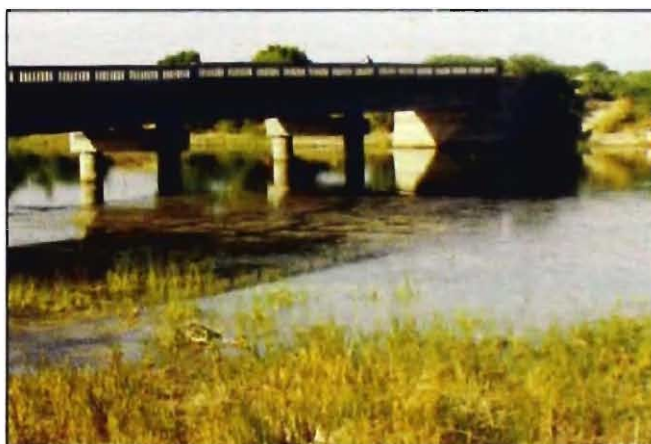
Submerged vegetation – a food for migratory birds



Emergent vegetation of reed – an ideal habitat for roosting & breeding of wetland birds



***Salvadora persica* at Pan bet – a common species of the bets at Nal**



Bridge at the Brahmini River entering Nalsarovar Wetland adjacent to Nani Kathecki villate



Nal Sarovar with open water and thick forested Dharabla Bet



Hinglaja Mata Temple at Pan Bet with Luxuriant Emergent Vegetation



Mota Chera in the horizon with receding lake waters and drying bed



Flamingos on shallow waters with fast receding lake waters



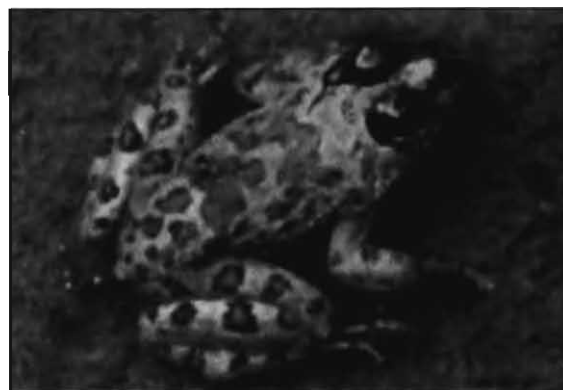
Saline pools with salt encrustation on dried bed of the lake Nal Sarovar in 2003



Parched land of Nal Sarovar during March - April, 2003



Haplobatrachus tigerina



Euphlyctis cyanophlyctis



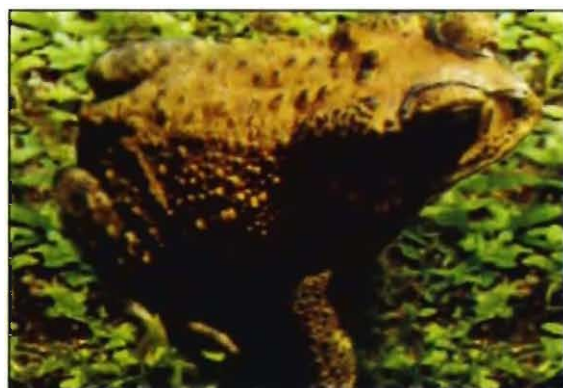
Euphlyctis hexadactyla



Limnonectes limnocharis



Bufo stomaticus



Bufo melanostictus



Microhyla ornata



Lissemys punctata punctata



Calotes versicolor



Mabuya carinata



Ophisops microlepis



Varanus salvator



Eryx johnii



Naja naja



Echis carinatus



Congregation of Flamingos at Nal at Sunrise



Lotus in the placid waters of Nal with a Wagtail



Sarus Crane : *Grus antigone* in the reads of Nal



Purple Heron : *Ardea purpurea* at Nal



Congregation of Little Cormorant :
Phalacrocorax niger at Nal



Painted Stock : *Mycteria leucocephala* at Nal



Brown Headed Gull : *Larus brunnicephalus* at Nal



Common Redshank : *Tringa tetanus* at Nal



Great White Pelican : *Pelecanus onocrotalus* at the Nal



Eurasian Spoonbill : *Platalea leucorodia* at the Nal



Common Shelduck : *Tadorna tadorna* at the Nal



Common Coot : *Fulica atra* in the open waters of Nal



Brown Headed Gull : *Larus brunnicephalus* at Nal



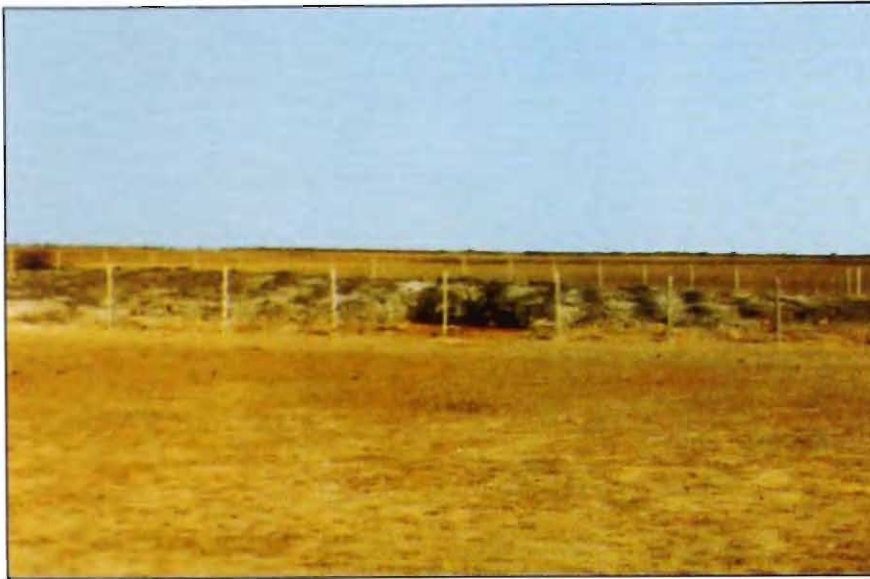
Indian Pond Heron : *Ardeola grayii* at Nal



Congregation of Demoiselle crane : *Grus virgo*
in the Nal environs



Common Crane : *Grus grus* on the perched
land of Nalsarovar



Bet stabilization by afforestation

**New Tourist complex outside
the Nalsarovar Wetland**



**Habitat development fro Wetland
avifauna for tourists**

Plate 7. Conservation measures at the Nalsarovar Wetland, Gujarat



Nalsarovar – Bird watcher's paradise and ideal habitat for ecotourism



Nalsarovar – An important Wetland habitat for Researchers



Forest Deptt. Establishment and Interpretation Centre at Nalsarovar

Plate 8. Nal Sarovar Wetland – A Biodiversity Conservation site in India



Fig. 22. Unregulated Fishing Activity

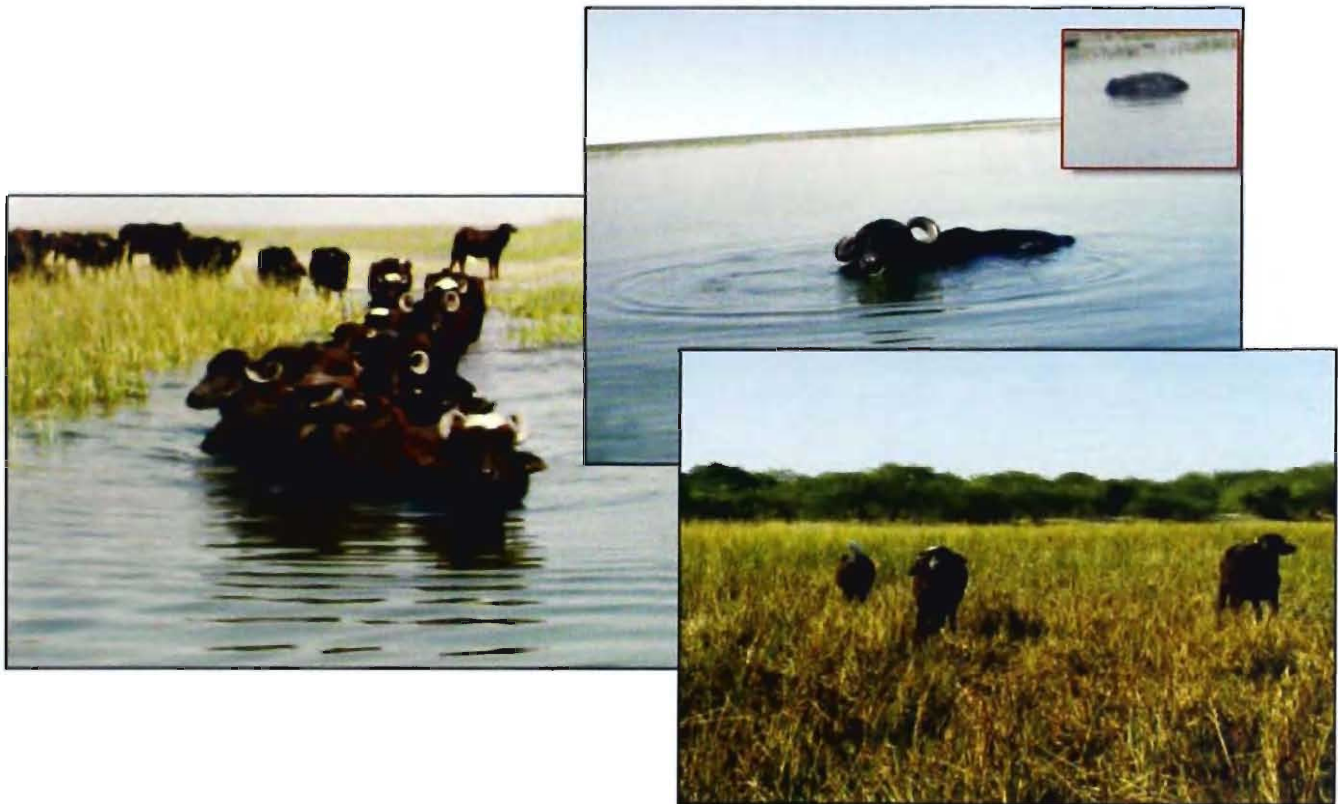


Fig. 23. Unregulated Grazing of Aquatic Vegetation



Fig. 24. Trapping and Poaching of Birds



Fig. 25. Encroachment of Bets by Cattle Owners



Fig. 26. Fodder Harvesting from the Lake bed



Fig. 27. Unregulated and Excess Pumping of water for Irrigation



**Fig. 28. Trespass by Boat/
Motor Vehicles on dried
areas of the Lake**

Fig. 29. Air Pollution

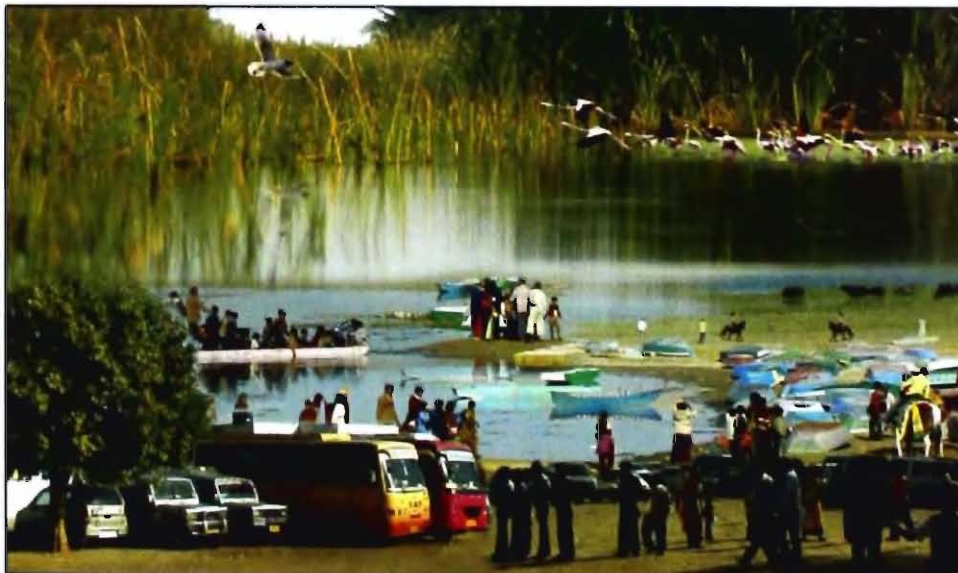
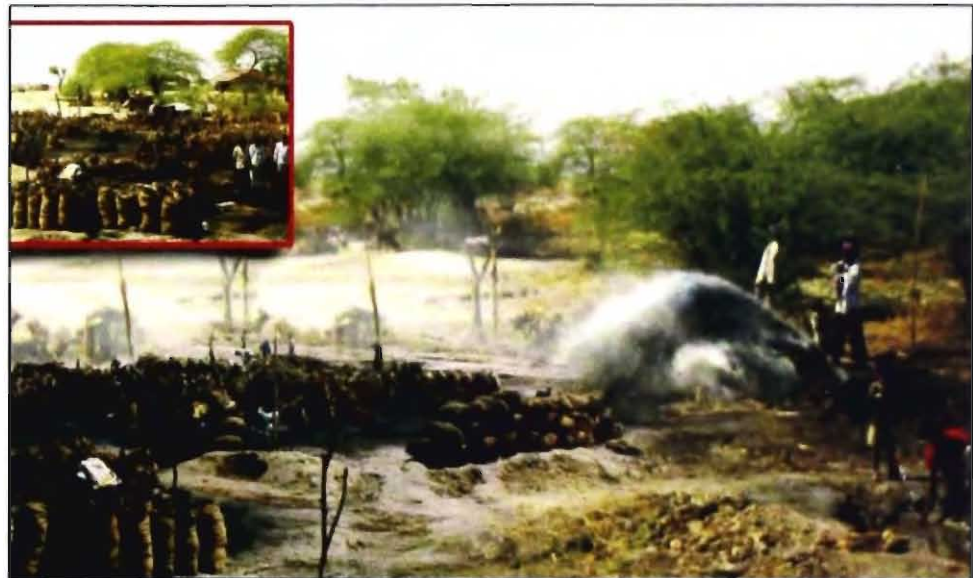


Fig. 30. Tourism Pressure