ECOLOGICAL ASSESSMENT OF FAUNA

at Nara Wetland Complex, District Khairpur, Sindh

Baseline Survey 2010 - 2011

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List of Acronyms

A	**Abundant**
As	**Arsenic**
BOD	**Biochemical Oxygen Demand**
C	**Common**
CAR	**Carnivore**
Cd	**Cadmium**
CE	**Critically Endangered**
CEMB	**Centre of Excellence in Marine Biology**
CITES	**Convention on International Trade in Endangered Species of Flora and Fauna**
Cl	**Chloride**
Cr	**Chromium**
DO	**Dissolved Oxygen**
DR	**Diurnal**
E	**Endangered**
EIA	**Environmental Impact Assessment**
GEL	**Global Environmental Lab (Pvt) Ltd.**
GIS	**Global Information System**
GPS	**Global Positioning Station**
GRN	**Grainivore**
Ha	**Hectare**
HRB	**Herbivore**
ID	**Index of Density**
IDER	**Indus Delta Eco-region**
IFAP	**Indus for All Programme**
INS	**Insectivore**
IUCN	**The World Conservation Union**
KC	**Kharochann**
KF	**Khebrani Forest**
LC	**Least Concern**
M	**meters**
MAF	**Million Acre Feet**
Mg	**Magnesium**
Mm	**millimeter**
MNVD	**Main Nara Valley Drain**
ML	**Manchar Lake**
NC	**Nocturnal**
NGO	**Non-Governmental Organisation**
Ni	**Nickel**
No.	**Number**
NR	**Natural Resource**
NT	**Near Threatened**

NWC	**Nara Wetland Complex**
P	**Protected**
Pb	**Lead**
Ppt	**particles per thousand**
SWD	**Sindh Wildlife Department**
VU	**Vulnerable**
WHO	**World Health Organisation**
WWF P	**World Wide Fund for Nature Pakistan**

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EXECUTIVE SUMMARY

WWF - Pakistan has initiated Indus Eco-region Programme, which is a 50 year vision. A total of 15 landscapes have been prioritized within the eco-region. The Indus for All Programme was initiated in July 2006 with the support from Royal Netherlands Embassy, as a beginning of the implementation of the visionary Indus Eco-region Conservation Programme. Implementation of *Indus for All Programme* at the first instance was implemented on four out of fifteen prioritized landscapes.

The second phase of implementation of *Indus for All Programme* has been started on another four prioritized landscapes, which are Kharochann (coastal), Manchhar Lake (Fresh water ecosystem), Khyberani Forest (irrigated forest) and Nara Wetlands Complex (wetland ecosystem). The programme aims to work with all relevant stakeholders at field, district, provincial and national levels to build capacity, support and influence planning and mainstreaming of poverty-environment issues.

Nara Wetland Complex in the Nara Desert Region is one of the four sites selected for the second phase. It extends from Ghotki, Sukkur, and Khairpur to Sanghar districts and is a part of Thar Desert biogeographical region which extends further south in Tharparkar area. The Nara Canal and associated wetlands form a complex of wetlands in the Nara desert region.

The area forms a part of Indo-gangetic plain formed by the gradual filling up of the trough lying between the foothills of Himalaya and central core of the sub-continent. On regional scale the area is a part of the Indus basin and is composed of alluvial sediments deposited by ancestral and present rivers and their tributaries crossing the alluvial plain. The alluviam brought by the River Indus lies over the basement of tertiary Shales and limestone. The other contributing rocks are granites, schists, gneisses and slates. The alluvium is quite rich in weathered minerals with soils deep and calcareous. The rocks belong to the Paleozoic, Mesozoic and Tertiary geological time scale. The soils of the study area were formed in acolian sands originally deposited in Pleistocene age but reworked by wind until recently to take the form of sand dunes. A minor extent of soils has been formed in a narrow alluvial plain of Nara Canal which has its origin in a small inundation river. The texture of the soils ranges from sandy to loamy fine sand but rarely very fine sandy loam in some areas along the Nara Canal. Soils are generally brown to greyish brown in colour with $CaCO_3$ content between 5 to 15%. Soils in the desert are generally non-saline, non-sodic and deficient in organic matter with a pH between 7.8 and 8.4. Salinity and waterlogging are common in irrigated areas particularly near the canal.

Nara desert consists of sandy hills, steep slopes and low lying flat areas locally known as Patt. The Nara canal flowing through the desert is associated with wetlands. The wetlands are natural, formed as a result of seepage from the Nara Canal. In general, the area around the Nara Canal is stable and the desert comprises of sand dunes having typical flat bottomed valleys between the dunes termed as 'Tars' or 'Tals'. The canal provides a

perennial source of water to the agriculture land extending 4 to 5 km on either side of the canal. Numerous dhands (pockets of water) are formed on either side of the canal recharged by either canal seepage or rain water.

The area is characterized by high wind velocity, massive shifting and rolling of sand dunes; high diurnal variation of temperature; scanty rainfall; extreme solar radiation and high rate of evapo-transpiration. The mean minimum and maximum temperatures are 20ºC and 45ºC respectively. The hottest months are May-July, when temperature ranges from 47 - 51ºC respectively. The lowest temperature 27-28ºC is recorded in the month of January. The annual rainfall ranges between 88 – 135 mm, mostly received between July and September (Qureshi & Bhatti 2008).

Nara wetland complex includes about 225 small, medium and large sized wetlands, some are seasonal, and most are permanent. These wetlands are fresh water to brackish to saline stretching from the town of Januji in the north to the Jamrao Head in the south. These wetlands lie on either side of the Nara Canal which is the largest canal of Sindh irrigating a cultivable area of 108 million hectares. It originates from Sukkur barrage along with Khairpur Feeder West and the Rohri Canal. Woodland, reverine forest, scrub and desert shrubs occur on both sides of the Nara Canal. The Mostwetlands are permanent brackish/saline/alkaline marshes/pools and permanent saline/brackish/alkaline lakes. The water source of these wetlands is seepage from Nara canal and surfacing of shallow ground water.

The vegetation on the sand dunes is sparse and consists mainly of drought resistant species such as *Calligonium polygonoides, Aerva javanica, Tamarix aphylla, Prosopis cineraria, Salvadora oleoides, Capparis decidua, Crotolaria burhia* and *Dipterygium glaucum.* The slopes have similar type of vegetation along with *Aristida adscensionis, Cassia italica, Tephrotia uniflora* and *Tephrotia villosa.* The Tarhs have a mixed growth of *Prosopis cineraria, Tamarix aphylla* and *Capparis decidua* besides patches of shrubs such as *Aerva javanica, Calligonium polygonoides* and *Dipterygium glaucum.*

The Nara canal is flanked by reed vegetation in most of the area. The vegetation consists of *Typha latifolia, Typha angustata, Paspalum distichum, Hydrilla verticillata, Nymphaea lotus, Polygonum hyaropier, Urticularia lotus, Nelumbium nuciferum, Desmostachya bipninata, Prosopis cineraria and Acacia nilotica.* Many wetlands have formed as a result of seepage from the Nara Canal. *Phragmites karka, Saccharum bengalensis, Tamarix indica* and *Typha spp* are common in this habitat.

The wetlands of the Nara Canal Wetland Complex have high social and economic values and functions as the people of the area are dependent upon them for drinking water, agriculture and for livestock grazing. In some wetlands, fish farms have been established. Very small to medium sized villages exist near the wetlands where the people are mostly involved in livestock husbandry. Agriculture and livestock farming are the main professions of the people of the area.

The Nara Canal and the belt of land along the canal is a Game Reserve, that was established in 1972. The ecosystem of the game reserve is a mixture of desert and the wetlands. Its total area is 108,960 ha along Nara Canal starting from Sorah to Jamrao Headworks.

The wetland complex can be delineated into four distinct habitats viz. Desert scrub, sand dunes, riparian forest and the proper canal area and its associated small and large natural lakes / ponds. The area is very important on account of its biodiversity which is unique for this part of the region.

A survey was conducted in the area in December 2010 and July 2011 for baseline data of the fauna of the area.

Large Mammals: twenty five animals of 10 different species, belonging to orders Carnivora (Jackal, Jungle Cat, Small Indian Mongoose, Grey Mongoose and Red Fox) and Artiodactyla (Wildboar) were recorded from the area.

The indirect evidence of presence of Hog Deer and Smooth-coated Otter was also recorded. Hog Deer, Smooth-coated Otter and Fishing Cat are the key mammalian species of the area (Ghalib *et al.* 2004). Roberts (1997) reported Smooth-coated Otter to be common in the lower reaches of the Indus, particularly around Sukkur and the east Nara. Rais *et al.* (2009) reported occurrence of Smooth-coated otter from Nara. According to IUCN Red list 2011, Hog Deer is endangered and Smooth-coated Otter is Vulnerable and both species have decreasing population trend globally.

Ghalib *et al.* recorded the occurrence of 18 large, medium sized and small mammals from the adjoining Nara Desert. These included Long eared desert hedgehog, Caracal or red lynx, Jungle Cat, Indian desert cat, Indian mongoose, Small Mongoose, Indian wolf, Desert fox, Striped hyaena, Ratel or honey badger, Indian Pangolin, Chinkara, Indian wild boar, Desert hare, Five striped Palm squirrel and Indian crested porcupine.

Small Mammals: Eight (8) species of small mammals belonging to three orders and five families were recorded. Out of eight species five were granivores, two herbivores and one omnivore.

Birds: The area has diverse habitat for bird species. The wetlands of the Nara complex are the important wintering and staging ground of the migratory water birds. The wetland complex has unique example of desert wetland ecosystem that hosts a variety of rare and endangered bird fauna.

A total of 118 species of birds belonging to 13 orders and 35 families were recorded. Out of 118 species recorded, 53 are winter migrants and 59 resident birds. These include the vulnerable species, Marbled Teal *(Anas angustirostris)* and Near Threatened species of Ferruginous Duck *(Aythya nyroca)*, and Indian Darter *(Anhinga rufa)*.

A pair of rare Whistling Teal *(Dendrocygna javanica)* was sighted at Jari Lake on August 6, 2005. This bird was not recorded from Nara earlier. A pair of Brahminy Starling *(Sturnus pagodarum)* during its breeding time was sighted in July 2005. The trend of presence of rare and endangered species recognizes the ecological importance of the area (Shamsi 2005).

Ghalib *et al.* (2008) recorded 78 species of birds from the wetlands of the adjoining Nara Desert Wildlife Sanctuary. These also included the threatened species *viz.* Indian white backed vulture and Houbara Bustard. They also recorded breeding of red wattled lapwing, white tailed plover, black winged stilt and black headed myna from the area.

Bailley (2005) recorded the occurrence of large pied wagtail *(Motacilla maderaspatensis)* and rock bunting *(Emberiza cia)* from Nara area which is for the first time from Sindh province.

The key species of the area include: Marbled Teal (Vulnerable), Ferruginous Duck (Near Threatened), Ruddy Shelduck (Least Concern), Indian Darter (Least Concern) and the Black or Red-naped Ibis (Least Concern).

Reptiles and Amphibia: The area is rich in herpetofauna; 24 species of reptiles belonging to 3 orders and 12 families were recorded. Out of the 24 species, two were herbivores, 13 carnivores and 9 insectivores.

Nara Canal and associated wetlands such as Kirchan, Nangopir dhand, Sim dhand, Simno Wahid dhand, Lalari dhand are important for supporting Marsh Crocodiles where 38 animals were sighted altogether. The other wetlands reported to be important for marsh crocodiles in the area are Torti, Somen, Harni, Ganjo, Shenhlo, Dholaho, Chaho, Samabi, Akhero, Badrami, Derhan and Chhoti dhand. There are reports of occurrence of about 200 marsh crocodiles in the area. Marsh Crocodile has been listed in Appendix I of CITES and is Vulnerable in IUCN Red list.

Three amphibian species belonging to Bufonidae and Ranidae families were recorded.

The main threats to the wildlife of the area are disturbance, hunting and land encroachment for human habitation. A lot of developmental activities are in progress which is ultimately causing disturbance to wildlife population and degradation of its habitat.

Chapter 1: INTRODUCTION

1.1.1 Introduction to Nara Wetland Complex

The Nara Canal and its either side has a wetland complex of about 225 small, medium and large wetlands, some are seasonal, most are permanent. These wetlands are fresh water to brackish to saline stretching from the town of Januji in the north to the Jamrao Head in the south. These wetlands lie on either side of the Nara Canal which is the largest canal of Sindh irrigating about 108 million hectares. It originates from Sukkur barrage along with Khairpur Feeder West and the Rohri Canal. Woodland, reverine forest, scrub and desert shrubs occur on both sides of the Nara Canal. Most of the wetlands are permanent brackish/saline alkaline marshes/pools and permanent saline brackish/alkaline lakes; about 200 ha each in extent and surrounded by sand dunes. Many dry out completely during winter and early spring.

These wetlands along with the aquatic vegetation, reed beds and woodlands are the habitat for a variety of mammals, birds, reptiles, amphibians and fishes. Thus the area is of immense ecological value for biodiversity. There is a very characteristic ecosystem having a chain of wetlands in a desert habitat.

The Nara Canal and associated wetlands form a complex of wetlands in the Nara desert region which extends from Ghotki, Sukkur, and Khairpur to Sanghar districts. This is a part of Thar desert biogeographical region which extends further south in Tharparkar area. The lakes/marshes are situated in the interdunal area and a unique or rare type of natural wetlands type found in the Thar Desert biogeographical region. This type of wetland system is not found elsewhere (with the exception of Chotiari Wetland Complex).

The area supports the vulnerable species such as: Smooth-coated Otter *(Lutrogale perspicillata)*, Marbled Teal *(Marmaronetta angustirostris)*, Marsh Crocodile *(Crocodylus palustris)*, It also supports the Near-threatened species such as Hog Deer *(Axis porcinus)*, Fishing Cat *(Prionalurus viverrina)*, Darter *(Anhinga rufa)*, White-eyed Pochard *(Aythya nyroca)*, Houbara Bustard *(Chlamydotis undulata)*, Ruddy Shelduck *(Tadorna ferruginea)*, Black Ibis *(Pseudibis papillosa)* and Indian Pond Turtle *(Geoclemys hamiltoni)*.

The Nara Canal Wetland Complex falls into the Thar Desert biogeographic province in the Indomalayan Realm. It is very important on account of its biodiversity which is unique for this part of the region. Hog Deer, Smooth-coated Otter, Marbled Teal, White-eyed Pochard, Houbara Bustard, Grey Partridge and the Marsha Crocodile are the key species of the area.

The area forms a part of Indo-gangetic plain formed by the gradual filling up of the trough lying between the foothills of Himalaya and central core of the sub-continent. On regional scale the area is a part of the Indus basin and is composed of alluvial sediments deposited by ancestral and present rivers and their tributaries crossing the alluvial plain. The alluvium brought by the River Indus lies over the basement of tertiary Shale's and limestone. The other contributing rocks are granites, schist's gneisses and slates. The alluvium is quite rich in weathered minerals with soils deep and calcareous. The rocks belong to the Paleozoic, Mesozoic and Tertiary geological time scale. The soils of the study area were formed in acolian sands originally deposited in Pleistocene age but reworked by wind until recently to take the form of sand dunes. A minor extent of soils has been formed in a narrow alluvial plain of Nara Canal which has its origin in a small inundation river. The texture of the soils ranges between sandy to loamy fine sand but rarely very fine sandy loam in some areas along the Nara Canal. Soils are generally brown to greyish brown in colour with $CaCO_3$ content between 5 to 15%. Soils in the desert are generally non-saline, non-sodic and deficient in organic matter with a pH between 7.8 and 8.4. Salinity and waterlogging are common in irrigated areas particularly near the canal.

The wetlands are natural formed as a result of seepage from the Nara Canal. In general, the area around the Nara Canal is stable and the desert comprises of sand dunes having typical flat bottomed valleys between the dunes termed as 'Tars' or 'Tals'. The canal provides a perennial source of water to the agriculture land extending form 4-5 km on either side of the canal. Numerous dhands (pockets of water) are formed on either side of the canal that is recharged by either canal seepage or rain water.

The area has arid sub-tropical climate, with very hot summers and cool winters. The average annual rainfall is less than 200 mm, most of the rain falling during the summer monsoons, June to September. Owing to the characteristic low rainfall and the absence of well-defined rainy season with frequently high temperature has limited the quantity of water not only in the *dhands* but also the canal itself.

The canal is one of the 14 main canals systems in Sindh with the largest cultivated command area. It originates from Sukkur Barrage having a designed discharge of 13,649 cusecs. The total cultivated command area is 1 million hectares.

The ground water aquifer in the areas along the Nara Canal has thickness up to 76 mm. The recharging rate of these aquifers is quite low owing to low rainfall in the area. In general, the water table ranges from 2.5 m to 5 m. With increasing distance from the Canal, the water table gradually increases reaching up to the depth of 10 m to 18 m in the eastern and western desert margin. Most of the aquifers in the area are unconfined located in sand deposits except in some places where the silt creates partially confined aquifers.

The water quality in the areas along and recharged by the Nara Canal is generally sweet with TDS ranges between 500 - 800 ppm. The water in the desert is mostly brackish having TDS between 10,000 to 28,000 ppm.

The climate of the region is arid with high temperatures and late summer rains. The rainfall is less than 250 mm and is in June to September. Before the monsoon period, the average temperature is 45°C in the desert areas and between 30° to 40° in the plains. The hottest and coldest months of the year are May, June and December, January respectively.

The Wetland Complex is of great hydrological values as 98% water of the Nara Canal is used for agriculture and 2% for drinking and domestic purposes. It is 361.6 km long and 90 - 135 m wide. The maximum water depth is 7.5 m. The highest discharges in Nara are reported in May-July and the minimum in August.

The canal system comprises of the upper Nara Canal lying between Sukkur Barrage and Jamrao Headworks and the Jamrao, Mithrao, Khipro and Thar Canal System that lie south to Jamrao Headworks. About 200 *dhands* exist along the Nara Canal, formed as a result of seepage from the Nara Canal. Some of the major *dhands* in the area are: Sadoro Faqir Ki Miani, Khaar-rhiyoon & Hazaari. *Dhands* within the desert area are a source of water for the locals and their livestock.

1.1.2 State of biodiversity

Nara is a rich ecological site and a unique habitat consisting of canal, wetland, riverine forest, desert scrub and sand dunes. The main habitats of the Nara Canal Wetland Complex are: the sand dune desert; the agricultural lands and the Nara Canal and the associated wetland system.

Desert:
The vast desert area is an area of sand dunes, interdunal valleys and low lying flat areas called "*Tarhs*". The vegetation on the sand dunes is sparse and consists mainly of drought resistant species such as *Calligonium polygonoides, Aerva javanica, Tamarix aphylla, Prosopis cineraria, Salvadora oleoides* and *Capparis decidua, Crotolaria burhia* and *Dipterygium glaucum.*
The slopes have similar type of vegetation along with *Aristida adscensionis, Cassia italica, Tephrotia uniflora* and *Tephrotia villosa.*
The *Tarhs* have a mixed population of *Prosopis cineraria, Tamarix aphylla* and *Capparis decidua* besides patches of shrubs such as *Aerva javanica, Calligonium polygonoides* and *Dipterygium glaucum.*

Cultivated areas
Cultivated areas occur near the water channels having crops like wheat, cotton, barley, sugar cane and sunflower. *Acacia nilotica, Prosopis cineraria, Salvadora oleoides, Tamarix aphylla, Dalbergia sissoo, Melia azadirach, Calotropis procera* and *Populus spp*. occur along the fields, roads and canals/irrigation channels.

Wetlands, marshes and salt pans

The canal irrigation system has given rise to seepage wetlands, water logged areas and saline soils. The Nara Canal runs through the area as the main canal for supplying water to the agriculture lands. The canal is flanked by reed vegetation in most of the area. There is dense growth of *Typha elephantiana, Alhagi maurorum, Saccharum bengalensis*, *Desmostachya bipinnata* and *Saccharum spontaneum.*
There are a number of wetlands formed as a result of seepage from the Nara Canal. Some are fresh water, while majority are brackish and hyper saline. *Phragmites karka*, *Saccharum bengalensis, Tamarix indica and Typha* are common in this habitat.

- **Mammals:** Hog Deer, Fishing Cat, Smooth-coated Otter, Wild Boar, Mongoose, Desert hare and Squirrel are reported from the area. The decline in vegetative cover has resulted in degradation of natural habitat of the Hog Deer as well as illegal hunting has declined its population severely.
- **Birds:** The wetlands of Nara are important habitat for a variety of bird species. As many as 118 species of birds have been recorded from the area. Marbled Teal, White-eyed Pochard, Darter, Houbara Bustard, Black Ibis, Long tailed Grass Warbler are reported from the area. The Marbled Teal is globally threatened but significant population has been reported to winter here. The area was significant for migratory water birds. In a survey in January – February 2004, more than 20,000 water birds were observed on eight wetlands of the area.
- **Reptiles:** Nara has a great significance pertaining to the distribution of herpetofauna. There are reports of occurrence of about 200 Marsh Crocodile *(Crocodylus palustris)* in Nara Canal and some of the adjoining *dhands*. During the survey conducted in December 2010 and July 2011, 29 crocodiles were sighted on five lakes. Altogether, 24 species of reptiles were recorded which include seven snakes, eleven lizards, five fresh water turtle and one crocodile
- **Amphibians:** Three species of frogs and toads were recorded.

1.1.3 Socio-economic status

According to the census report of 1998, the population of Nara taluka is 92,387. The total population of the target area can be estimated to be 50,000. The main tribes living in the area are Syed, Shar, Chang, Rajpar, Ardhin, Dasti, Malah, Khaskheli, Chano, Sahtha, Gopang, Bhurgari, Rid, Nizamani and Baloch. Agriculture and livestock are the main occupations of local people. A small number of people are also engaged in artisan work, trade, business and job in government departments etc. Wheat and cotton are the major crops grown in the area while barley, sugarcane, oil seed, pulses, vegetable and fodder are also grown. Locals have the least health facilities and there is a lack of employment opportunities.

1.2 Rationale and objectives

1.2.1 Large Mammals Survey

1.2.1.1 Rationale

WWF - Pakistan has initiated Indus Eco-region Programme, which is a 50 year vision. A total of 15 landscapes have been prioritized within the eco-region. Indus for All Programme was initiated in July 2006 with the support from Royal Netherlands Embassy, as a beginning of the implementation of the visionary Indus Eco-region Conservation Programme. Implementation of *Indus for All Programme* at the first instance was implemented on four out of fifteen prioritized landscapes viz. Keti Bunder (coastal), Kinjhar Lake (Fresh water ecosystem), Pai Forest (irrigated forest) and Chotiari Reservoir (wetland ecosystem). This programme will continue till June 2012.

The second phase of implementation of *Indus for All Programme* will start on another four prioritized landscapes, which are Karochan (coastal), Manchar Lake (Fresh water ecosystem), Khebrani Forest (irrigated forest) and Nara Wetland Complex (wetland ecosystem). The programme aims to work with all relevant stakeholders at field, district, provincial and national levels to build capacity, support and influence planning and mainstreaming of poverty-environment issues.

The preliminary ecological assessment of the project sites has been initiated as an output of the programme to establish a baseline in and around the abovementioned sites. The baseline will determine key livelihoods interventions of *Indus for All Programme* by identifying the gaps and opportunities.

As a part of the ecological assessment and to study the mammalian fauna of the project sites, the study sites were visited twice; firstly during winter in November – December 2010 and secondly in summer during July 2011. Each visit of all the four sites was of 2-4 days duration.

1.2.1.2 Objectives of the study

a. Identify various large and medium sized mammals in the study area, develop a checklist and estimate the populations of some key mammalian species.
b. Assess the major threats that are likely to affect the survival of large mammals and suggest mitigation measures to those threats.
c. Identify key habitat and associated features of the large mammals habitat

1.2.2 Small mammal survey

1.2.2.1 Rationale

Small mammals are an indispensable component of fauna and they play an important role in determining the holding capacity and maintenance of the number of animals in the higher trophic level of the food chain. They not only maintain ecological balance in an ecosystem, but also play a specific role in biological control, necessary for a self sustained ecosystem. These small animals fill niches and depend upon the submerged roots, fallen seeds, rhizomes and bulbs, insects, snakes, scorpions, spiders and beetles for their food. They are in turn eaten by larger animals like foxes, jackals, cats, owls, eagles, kites, falcons and wolves living in a particular ecosystem. To determine the status of large mammals it is necessary to obtain data on small mammals.

Role of small mammals usually stem from perceived negative values associated with their role as pest and disease spreading animals. Small mammals however, play an important and perhaps indispensable role in the functioning of an ecosystem. They should not be viewed separately from other components of the ecosystem. Rather, they must be viewed in terms of their interrelationships with other components. Small mammals influence the structure and function of ecosystems as consumers of plants and small animals as movers of soil and soil nutrients, and as the primary prey of raptors, snakes, hawks, eagles, owls and carnivorous mammals. Because of their intermediate trophic position and high dispersal abilities, small mammals may track changes in biotic and abiotic environment that result from shifts in land use practices and other human activities.

Researchers have proposed various ways in which small mammals interact with plant communities. The main interactions can be categorized as those relating to primary productivity, plant species composition, plant stature and reproduction and decomposition rates of plant materials. Small mammal herbivores may consume as much as 60% (Migula *et al.* 1970) of the total annual primary plant production. They may have localized, large scale impacts on primary productivity during population explosions. However, the effect of direct consumption of plants by herbivores must be evaluated in terms of what portion of the primary production is actually available to the animal. Estimates of vegetation consumption by small mammals ranged from <1% in short grass and mid grass sites to as much as 20% in desert grasslands (French *et al.* 1976). Harris (1971) has estimated that 0.17-5.01% of the net primary production was transferred to the rodent trophic level.

Small mammals have been credited with changing plant community composition and species distribution. Plant communities in many parts of USA have been altered by extensive damage to big sage brush during cyclic population peaks of voles. Control of pocket gophers in western Colorado resulted in an increase of perennial forbs (Turner 1969) while grass and sedge densities were higher in areas where gophers were present. Small mammals can also alter plants community composition and species distribution by consuming and caching seeds. They can also influence plant community composition by heavily grazing or damaging plants, and thus reducing their ability to produce seeds.

Seed caching activities of small mammals can alter plant distribution by either increasing or decreasing survival of plants. Yet, dispersal of seeds by small mammals can result in increased germination and survival. Some organisms may be dependent on small mammals for seed or spore dispersal. Many fungi and nitrogen fixing bacteria and yeast depend on small mammal mycophagy for spore dispersal (Fogel and Trappe 1978).

The rate of plant succession may be affected by small mammal burrowing and feeding activities. The mounds of small mammals disrupt grass associations and provide bare soil for the invasion of lower succession plants, thereby increasing the diversity of plants. Selective herbivore by small mammals can also alter plant succession rates. Rodents may aid in the recovery of overgrazed grasslands by selectively grazing on weedy plant species (Gross, 1969).

Small mammals can influence the rate of decomposition of organic materials by adding green herbage and excrements to the litter layer and by reducing the particle size of vegetative material. They are more efficient in effecting the mineralization of organic matter than either insects or ungulates (Golley *et al.* 1975). Voles affect decomposition rates by altering microclimatic conditions in the litter layer and by deposition of excrements and vegetative cuttings into litter layers, which increases micro-organism growth (Zlotin and Kodashova 1974). Reduction of particle size of living and dead vegetative material by small mammals also increases decomposition rates.

Soil structure and chemical composition are affected by the activities of small mammals. Burrowing activities largely influences soil structure. Burrowing and the addition of feces and urine to the soil influence soil chemical composition through changes in nutrient and mineral cycling rates and pathways. Soil structure may be altered as small mammals burrow, bringing large quantities of mineral soil to the surface. Pocket gophers are reported to excavate 18 metric tons of soil material per hectare per year (Hole 1981). Abaturov (1968) estimated that mole burrows covered 36% of woodland ground surface, which resulted in increased soil porosity and drainage, and altered soil water holding capacities. Soil mounds resulting from small mammal burrowing are strongly heated and the surface crust that rapidly forms prevents evaporation. As a result, at depths of 5-20 cm the water content of the soil under mounds is 7 – 82 higher than at corresponding depths in virgin soil (Zlotin and Kodashova 1974).

The most significant role of small mammals may be their effect on the chemical composition of soils, particularly the addition and incorporation of nitrogen. Soil chemical composition can be altered by the addition of excreta and by upward displacement of nutrients through the soil profile.

Small mammals function as secondary consumers in the ecosystem by preying on invertebrates and on other mammals, which may have direct impacts on prey production. Insectivorous species may exert a regulatory effect on invertebrate populations; small mammals consumed a high percentage of invertebrate populations in nearly all grassland sites studied by French *et al* (1976). Carnivores have been shown to influence prey

species densities. Hayward and Phillipson (1979) estimated that weasels consumed as much as 14% of the small mammal production, resulting in a reduction in the impact of small mammals on the rest of the ecosystem. Secondary consumption may indirectly influence primary production. Plant consumption by invertebrate herbivores may be reduced by the insectivorous feeding habits of small mammals. Destruction of small mammal predation may serve to reduce invertebrate species that are themselves predators of phytophagous insects. Small mammals also affect Land bird species. Nest predation by small mammals is the major cause of nest failure in passerines and nesting success of land birds.

Small mammals serve as a food supply for a large number of predators and can exert significant influence on predator population cycles. Small mammals, especially rodents are characterized by high productivity rates, and thus even at relatively low densities, are an important source of food for predators. Densities of small mammals can have profound impacts on the reproductive potential of some predators. For example, the proportion of tawny owls that bred each year in England varied from 0 to 80% according to the number of mice and voles present (Southern, 1970). Several authors have documented cases where population levels of predators can be traced to small mammal densities. For example, population declines in black-tailed jackrabbits *(Lepus callfornicus)* induced significant decreases in numbers of coyotes *(Canis latrans)* in north-western Idaho and southern Idaho (Clark 1972) and kit foxex (Vulpes macrotis) in western Utah (Egoscue, 1975). Raptors, such as the great horned owl, may increase as much as five-fold during years of high densities of snowshoe hares in Alberta (Mclnvaille and Keith, 1974). Further, population outbreaks of small mammals can induce predators to switch from preferred prey, thus reducing predation on some game species.

1.2.2.2 Objectives of the study:

a. Collect data from the field on species occurrence, abundance and diversity of the study areas;
b. Collect and review secondary data on small mammal species of the study sites, using the available literature and knowledge of the local inhabitants.
c. Prepare a taxonomical checklist of the species of small mammals based on field observations, sampling and secondary data.
d. Identify threatened mammalian species in the Indus for All Programme sites and recommend conservation measures;
e. Study the behaviour of various species of rodents and other associated groups in relation to the habitat and diet in the study sites.
f. Assessment of impacts of environmental changes and human population pressure on potential mammalian species and their habitats. Associated mitigation measures are to be suggested.
g. To identify the key species of small mammals inhabiting the area.
h. To identify impact of small mammals on the overall livelihood of the people.

1.2.3 Reptiles and amphibians

1.2.3.1 Rationale

Reptiles and amphibians are important vertebrate fauna. Amphibians show the transition from aquatic to terrestrial life. Apart from their impressive evolutionary history, they demonstrate different concepts of physiological and behavioral adaptations to different climates, from tropical forests to hot deserts and marine to fresh water. They do not have the ability to travel long distances like birds and mammals. In response to any local environmental changes they respond quickly and therefore may act as excellent biological indicators.

Amphibians and reptiles are important components of any living system and play a key role in the interlocking web of nature. At one end they prey upon insects and other invertebrates and therefore regulate the population of these animals and on the other hand they are also a major source of food for other carnivore species (birds and mammals). Their position in the ecological niche is so vulnerable that the survival and collapse of the whole energy cycle depends upon the presence and absence of amphibians and reptiles. The existence and sustainable use of this biological resource is therefore imperative around the study sites.

Despite the fact that amphibian and reptiles are an important biological resource, very little attention has been paid to them in Pakistan. The major hurdle presumably is the lack of expertise and awareness in this particular field. Moreover, our society in general and rural folk in particular is mostly repulsive and afraid of reptiles. The results of the present study will provide information on reptiles and amphibians of the Programme sites. Furthermore, the status of all the species of Amphibians and Reptiles will be evaluated so that in any adverse circumstances the conservation strategies could be suggested.

1.2.3.2 Objectives of the study:

a. Collect and review secondary data on the reptile and amphibian species of the study sites, using the available literature and local inhabitants.
b. Collect data from the field on species occurrence, abundance and diversity in the study areas.
c. Prepare a taxonomical checklist of all the species with their English and local names and their status in the study sites.
d. Identify threatened amphibian and reptile species in IFAP sites and recommend measures to improve the situation.
e. Study the behaviour of various species of amphibians and reptiles in relation to habitat and diet in the study sites.
f. Assessment of impacts from environmental changes and human population pressure on potential reptilian and amphibian species and their habitat and to suggest associated mitigation measures.

1.2.4 Birds

1.2.4.1 Rationale

Birds are natural indicators of the health of an ecosystem. When birds disappear from an area or have declining trend in population, it indicates the deteriorating health of the ecosystem.

The area of Indus valley is known as the best part of Pakistan for waterfowl (Koning 1987) with large areas of southern deltaic zone annually inundated during the monsoon season whilst in winter and spring the water recedes, evaporates or is used for agricultural purpose, such conditions being ideal for wintering scores of waterbirds.

1.2.4.2 Objectives of the study:

a. Conduct a review of literature on bird fauna
b. Develop a species inventory of the resident and migratory birds with notes on relative occurrence and distribution of each programme area
c. Conduct a site specific study on main habitats important to bird species including habitats of critical importance.
d. Record human impact on resident and migratory bird population.
e. Document and describe bird species of "Special Concern" with economical and ecological perspective both in resident and migratory avifauna found within the study site.
f. Conduct studies to describe and assess anthropogenic impacts on bird species founding the study area.

1.2.5 Physico-chemical properties of water

1.2.5.1 Objectives of the study

a. Review and complete baseline surface hydrological conditions, baseline ground water conditions, baseline of water quality levels in the area;
b. Collect accurate field measurements for pH, Zinc, Cyanide, Nitrate, C.O.D., oil and grease, conductivity, light transparency/turbidity, total Coli forms, Fecal E. coli, hardness, fecal Enterococci/Streptococci, Chlorides, Arsenic, and alkanity according to approved procedures;
c. Analyse data to identify water quality contaminants of concern levels and extent of contaminating to determine ambient conditions, trending and cause/effect relationships for each area.

CHAPTER 2: MATERIAL AND METHODS

Faunal data was collected by different methods for each group of animals as described below. During field work, locations within the different habitats that exist in the area were sampled. The sampling locations were randomly selected, ensuring that in each habitat type sufficient location are sampled so that maximum number of species could be encountered and recorded.

2.1 Large Mammals

2.1.1 Team Composition

The study team comprising of 2-3 members conducted surveys in Nara Wetland Complex. Both nocturnal and diurnal surveys were undertaken.

2.1.2 Point surveys

In this method, observation points were established along roads, edges of ponds or marshes, at a higher place or at any other location suitable for viewing the habitat. For a period of 15 to 60 minutes at each observation point, the observer recorded all sightings of the mammals at that site.

2.1.3 Roadside Counts

Usually it is difficult to locate a large mammal by walking in its habitat, as it can smell the human from a long distance. Hence the method of roadside counts was applied mostly for the nocturnal mammals like foxes, jackals, cats, hog deer and wild boar as well as for the diurnal mammals like mongoose. For this purpose, 4x4 vehicles were used which were driven at a slow speed (7 km/hr). These roadside counts were carried out during early morning at dawn and during night by using search lights.

2.1.4 Track Counts

Tracks can be the first indication of the presence of animals in an area. Track counts especially after rain can be useful in identifying different animals especially those which are nocturnal and secretive in habits. As fresh rain eliminates the previous tracks so the recent tracks of animals entering or leaving the study area can be used as a measure of their abundance.

During the survey period, track count technique was applied at all the four study sites and this method proved very effective to determine the presence of cats, otters etc.

2.1.5 Line transects

The line transect or strip census method of population estimation involves counting the animals seen by an observer traversing a predetermined transect line and recording the animal and distances on the both side of the strip at which they were observed. The length of the strip multiplied by the average total distance of both sides of the strip is the sample area.

Line transects or strip census method is particularly useful technique when animals are difficult to be seen and must be flushed to be counted.

2.1.6 Pellet counts

Pellets' counting in a specific area is a good technique for locating large mammals and assessing their populations. The technique involves removing all pallet groups from plots and then estimating from subsequent observations on those plots and number of groups per hectare to compare animal use of areas between sampling periods. In some cases it is not possible to remove all the pellet groups from an area therefore under such circumstances; an observer with a little practice can identify the fresh pellets depending on the color and dryness of the pellets. Ten to fifteen 100 m^2 plots (7.07 x 14.14) can be used for this purpose. These plots should be checked every three to seven days and the periods between samplings should not be so long that feces will decompose or be destroyed by weather or insects. A random selection of plots in the study area and the number of pellet groups in each plot is tallied and summed (Bower *et. al* 1990). An index of density (ID) of the number of pellet groups per unit area is then determined as:

$ID = n / A$
Where n is the sum of pellet groups counted over all plots and A is the total area sampled (i.e. the sum of the areas of all plots).

This method is effective in the habitats with dry weather and little or no dung beetle activity where pellet groups remain preserved between sampling periods.

After counting pellets, one must be assured that they will not be counted on successive sampling periods so they should be removed by the observer. Defecation rates for the species under the study are closely estimated if it is desired to convert pellet counts to number of animals.

2.1.7 Interviews with local residents

Interviews with local residents are valuable not only for the survey site selection but also in identifying the potential areas and a good source of primary data about the existing wildlife of the area. This method was very helpful in locating different mammal species in all the four study sites. However, despite the effectiveness of this method, minimal

emphasis was placed on this source regarding the population of different animals as it is assumed that the data regarding the population estimates could be biased.

2.1.8 Equipments and Field Kit

Equipments and field kits used for watching different mammals and assessing their populations in different study sites included:

1. Digital camera to record the photographic evidences of the mammals
2. Search lights for night vision of nocturnal mammals on 4x4 vehicles.
3. Measuring tape to record the size of foot prints and fecal droppings.
4. Binoculars (10x50) to observe the diurnal large mammals.
5. Geographical Positioning System (GPS) to record the coordinates.
6. Field guide books for assistance in quick identification of mammals.
7. Note book and pencils for recording field notes.
8. Satellite maps of the study sites.

2.2 Small Mammals

It is an effective way to survey mammals in active searching, particularly during the daytime. This method is equally applicable to both nocturnal and diurnal species. The study area was actively searched for potential and suitable microhabitats along the canal banks, open plains, bushy areas and agriculture fields. Active searching is very effective for inventory of *Gerbilus*, *Meriones*, *Hysrix* and *Hemiechinus species*. This method is most effective for those small mammals which cannot be trapped easily e.g. Hedgehog.

To investigate nocturnal species, night surveys were conducted in exposed areas of potential habitats on the ground. This methodology involved the use of a powerful 4orcH light, sticks, long boots, gloves etc.

2.2.1 Bait

A mixture of different food grains mixed with fragrant seeds was used as bait for the attraction of the small mammals. Wheat and rice were used as food grains while peanut butter, coriander, oats and onion were used as fragrance. This bait was found highly successful in the study area due to the overall food shortage and fragrance. Freshly prepared bait was used on every trapping morning. Only small amount of bait was placed on the platform fitted on the rear side of the trap.

2.2.2 Traps and trapping procedure

Sherman traps were used for the present studies to collect the live specimens. Fifty traps were set at a specific area on a line approximately 500 m long and traps were set approximately 10 m apart. Each trap was marked by a colorful ribbon to locate the traps easily. The traps were set in the afternoon and checked early in the morning. The

specimens were transferred into polythene bags and were identified in the field and released. The specimens with some doubt were preserved in 10% formalin and were sent to the laboratory and identified using identification keys. At least one specimen preserved for reference.

2.2.3 Data collection

The species of the trapped animal was noted as was the net weight, gender and other relevant information such as date, habitat, location, elevation and weather conditions.

2.3 Reptiles and amphibians

2.3.1 Survey method

The activities of amphibians and reptiles are highly seasonal and are influenced by the variation of weather even on a daily basis due to their exothermic and cryptic nature. It is more fruitful to survey them during their activity periods. Amphibians are usually most active just after dusk during their breeding season; many diurnal reptiles such as skinks and some lizards are active in mid-morning whereas nocturnal reptiles such as certain skinks and some lizards are active in mid-morning whereas nocturnal reptiles such as certain snakes and geckos would be active only at night.

Most amphibians and reptiles go into hibernation during winter. They would be under-estimated if surveys were carried out during this time. As such, it would be essential to survey herpto-fauna at appropriate timings in order to collect a representative baseline for assessment. Many reptiles such as snakes and lizards are timid, secretive, fast moving and cryptically colored. This renders survey of reptiles difficult. The reptiles therefore tend to be under represented in ecological surveys in general. More intensive surveys with appropriate survey methodologies would rectify such limitations.

There are standard methods for the studies of Amphibians and Reptiles (Foster and Gent, 1996; Hayek and Martin, 1997). All these techniques have been summarized in the EIAO Guidance Note, 2004. A brief summary is given below:

2.3.2 Active searching

An effective way to survey amphibians and reptiles is by active searching particularly during the day time. This method is equally applicable to both nocturnal and diurnal species. The study area was actively searched for potential breeding areas of amphibians (e.g. marshes, small water poles, water channels) and suitable microhabitats for both amphibians and reptiles (e.g. stones, pond bunds, crevices, leaf litter/debris, rotten log).

These places were deliberately uncovered to search for the eggs and tadpoles of amphibians and aquatic habitats or to reveal the presence of the amphibians and reptiles hiding under these covers. Active searching was carried out in all the locations with a

focus on suitable microhabitats. In winter, most of the active searching was only possible and limited to the pre-dusk time, as the low night temperatures hindered the activities of the herpetiles.

Searching for the nocturnal species of amphibians and reptiles was carried out in exposed areas of their potential habitats on ground, along the path or the pond/stream bank.

2.3.3 Trapping

'Pit – fall' trapping is one of the efficient methods of collecting amphibians and reptiles. Pitfalls however require regular monitoring, which is not possible in short term surveys. The most suitable location for such traps is the sandy habitat, which yields great success in trapping the animals. The drifts along which traps were placed/set, guided the animals to fall into the traps. Some leaf litter was put in the set trap to provide cover and moisture for any amphibians and reptiles, trapped inside. The traps were checked regularly within a reasonable time period, at least once per day, to avoid stress and death of trapped animals.

For the "Active Searching" and "Pit-fall trapping" requisite activities including Observations, Identification, Collection and Preservation were made as per plan of the studies.

2.3.4Signs

Presence of signs like impression of body, tail or footprints, faecal pellets, tracks, dens or egg laying excavations were also some of the suitable methods to find out the existence, range and rough population of amphibian and reptilian fauna.

2.3.5 Collection

Hand picking (through bare hands or with the help of long forceps or snake clutch adopted for the present studies, has always been the most efficient way of collecting different species of amphibian and reptiles. However, for larger species like monitor lizard and rock agama, noose traps or other appropriate techniques were used. For handling snakes, especially poisonous ones, snake clutches/sticks were used. In addition to Hand picking, Scoop nets for shallow water and Cast nets in large water bodies were used for aquatic reptiles and amphibians. For frogs and toads, auditory detection of mating calls at the breeding sites is considered as an efficient method to find out the species; particularly the more vocal species and like toads.

2.3.6 Data Records

The species collected or observed during the survey were photographed with the digital camera and necessary field data were recorded. The coordinates and elevations were

recorded with the help of GPS. The voucher specimens collected were subsequently provided to the Zoological Survey Department for reference.

2.3.7 Preservation

The amphibian or reptile specimens were arranged in a tray in a position, which showed the features important for identification, e.g. mouth wedged open, one hind leg extended and fingers and toes spread. Preservatives such as 10% Formalin solution or 50-70% alcohol or methylated spirits solution in water was added to just cover the specimens, and the container was then covered and left until the specimens were set. In case of larger specimens, a slit was made in the belly and preservative was injected to preserve the internal organs. This step was omitted in case of frogs as they have thin and permeable water proof label was added to the jar, giving details of place, date and collector's name. A label was tied to the specimen written with permanent Indian ink or simple carbon pencil. The same details were stored with tadpole specimens, which don't need to be set, just dropped into preservative.

2.3.8 Identification of species

The specimens were identified with the help of most recent keys available in literature (Khan, 2003 and 2006)

2.3.9 Data Analysis

There are several numerical indices in use, which qualitatively describe different levels of diversity and evenness in samples collected from different localities or at different times from the same environment. One such commonly used diversity index is called "Shannon-weaver" index of diversity, which combines the number of species present and evenness into a single index. The formula is given as:

$D = - \Sigma$ pi in pi, where "i" stands for an index number for each species present in a sample, "pi" can be calculated through "ni/N" in which "ni" represents the number of individuals within a species divided by the total number of individuals "N" present in the entire sample and "ln" stands for natural log. In this way the proportion "pi" of each species in the sample times the natural log of that same value "ln pi" the values for each species and finally multiplied by -1. The value of "D" is always higher when species are equally abundant.

Similarly species evenness is calculated by the formula as:

$E = eD/s$, where "e" is the Shannon-weaver constant valuing 2.7, "D" is the value of Shannon-weaver index and "s" represents the number of total species in a sample. Species evenness, thus, separates the effect of different population sizes (number of individuals within species) from number of species (species diversity).

2.4 Birds

2.4.1 Survey Method

The major habitat types in the study area available for birds were identified. The species and numbers of birds of each species found in each habitat type were recorded with particular emphasis on the key species. The data was also related to other components of the study area such as vegetation, water and soil etc. The field surveys covered both migratory and breeding of birds.

The most commonly used field method in bird surveying is the "Line Transects" method. It is based on recording birds continually along a predefined route within a predefined survey unit. It can be used in terrestrial, freshwater or marine ecosystems to survey individual species, or group of species. It is used to examine bird-habitat relationships and to derive relative and absolute measures of bird abundance.

Line transects are suitable for extensive, open and uniform habitats and for large and conspicuous species. Double counting of birds becomes a minor issue as the observer is continually on the move. Line transects are suited to situations where access is good and these are very useful for bird-habitat studies (Gregory *et al.,* 2004).

In the present studies, each sample area was traversed and examined by two observers separately. Birds were searched on each side of the strip for 150 m so that each study strip was 300 m wide. Binoculars and telescopes were used to identify bird species and count or assess bird numbers.

2.4.2 Evaluation of water bird numbers

To evaluate the numbers of water-birds utilizing a site, observation is made from a stationary point or by moving through the area using binoculars and telescopes. Below is a summary of when to count accurately or estimate the numbers of water-birds present:

a) Counting individual birds within an area

- Small number of birds present *i.e.* <1,000
- Limited inter – or intra – site movement by water-birds *i.e.* the birds are stationary at a roost site.
- No on-site disturbance *i.e.* people or birds of prey, which may force birds to fly frequently within the site.
- The birds are well spaced out *i.e.* foraging in an open area.

b) Estimating the numbers of birds within an area

- Large numbers of birds present *i.e.* >1,000
- Birds continually in flight i.e. moving along the coast to a roost site in large flocks.
- A lot of disturbance forcing birds to be unsettled and continually take flight, making prolonged observation on the ground difficult.

- A closely packed flock of birds, where due to 'tightness' of the flock counting individual birds is difficult *i.e.* at a large roost.
- Due to poor light conditions *i.e.* viewing into the sun or over a great distance, identification of particular species is not possible.

2.4.3 Methods of accurate count

- Close viewing of individuals with binoculars or a telescope. Counting 1,2,3,4,5,6,…….etc.
- Distant viewing of an evenly distributed flock. Counting 1,2,3,4,5,6……etc.
- Visually dividing birds into small groups and counting each group individually, i.e. when there is an uneven distribution of numbers. Totals for each group are then added to form the final total.
- Counting flocks in multiples i.e. 3,6,9,12,15…….etc. or 2,4,6,8,10…..etc. This method can be used for either evenly or unevenly distribution of water-birds. (Howes, J. and Backwell, D. 1989).

Since all the birds would not be resident in the area, they may be either, winter visitors, passage migrants, summer (breeding) visitors or resident etc. Hence, an attempt was made to cover all the recognized breeding and wintering habitat types in the area with at least one survey carried out over the summer and one in winter season for each habitat type.

2.5 Physico-chemical Properties of Water

The samples were collected on 6th February 2011 in clean acid rinsed bottles for the general water quality parameters such as pH, Chloride, Conductivity, Turbidity, Total Hardness, Total Alkanity, Cr (Hexa), Lead, Zn, COD, Iron and As.

The COD water samples were collected in separate coloured water bottles and kept in ice box for preservation. All samples were properly sealed under specific codes/labels and dispatched to the GEL Laboratory the day after the collection with proper custody protocol.

The sampling strategy was designed according to the site conditions and in consultation with the WWF team. Water samples were drawn considering full depth of standing water or flowing water.

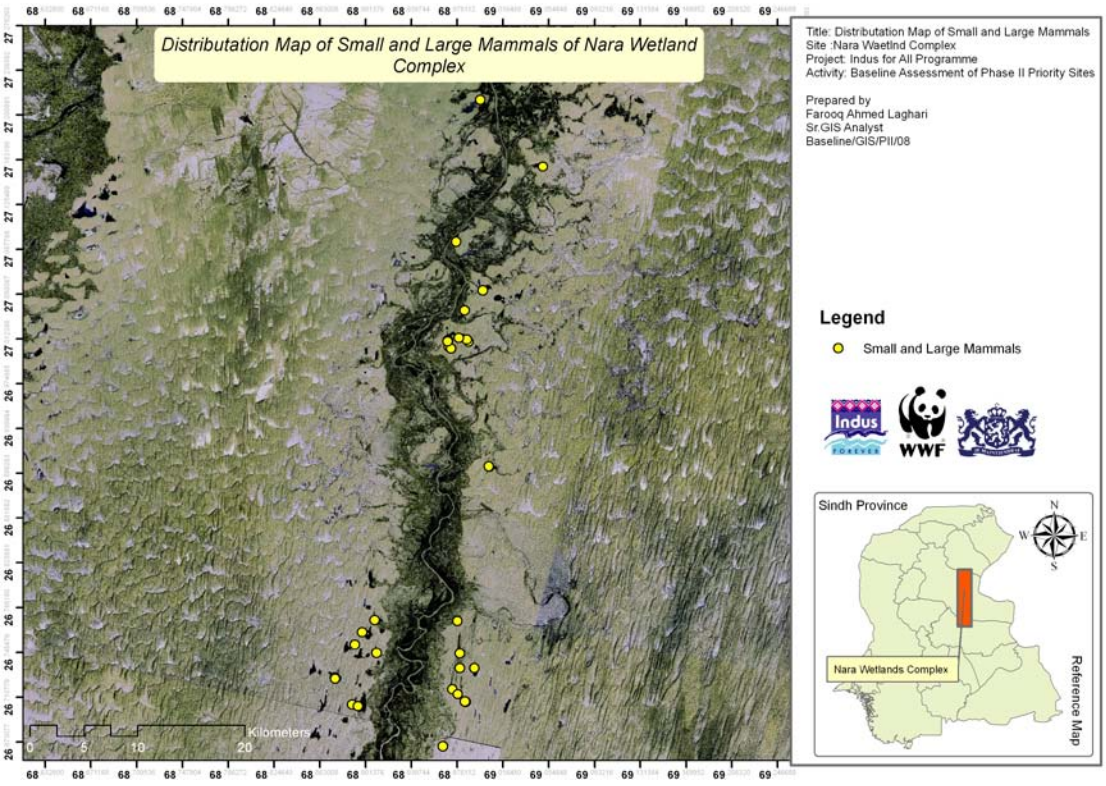
CHAPTER 3: RESULTS AND DISCUSSION

3.1 Large Mammals

3.1.1 Observation Sites

Almost all the potential sites around Nara wetlands complex were searched to locate the existing large mammals and the GPS coordinates at different locations were noted. Different sampling sites and the distribution of large mammals during winter and summer surveys are given in Map 2 and 3 respectively.

Map 2 – Sampling locations of large mammals in Nara Wetland Complex



3.1.2 Species identified

A total of ten species of large mammals belonging to two orders (Carnivora and Artiodactyla) were recorded from the study area, as given in Table 1 below:

Table 1 – Large Mammals recorded from Nara Wetland Complex

S. No	Common Name	Scientific Name	Order	Animals Observed
1	Asiatic jackal	*Canis aureus*	Carnivora	5
2	Jungle cat	*Felis chaus*	Carnivora	1
3	Fishing cat	*Prionailurus viverrinus*	Carnivora	-
4	Desert cat	*Felis silvestris*	Carnivora	-
5	Red fox	*Vulpes vulpes*	Carnivora	1
6	Smooth-coated otter	*Lutrogale perspicillata*	Carnivora	-
7	Small Indian mongoose	*Herpestes javanicus*	Carnivora	10
8	Grey mongoose	*Herpestes edwardsi*	Carnivora	4
9	Hog Deer	*Axis porcinus*	Artiodactyla	-
10	Indian wild boar	*Sus scrofa*	Artiodactyla	4

3.1.3 Observation Records

Out of ten recorded species of large mammals, six were observed directly while four species were recorded on the basis of indirect evidences like tracks, feces and interviews of locals. Observation records of different mammal species at Nara Wetland Complex are given in Table 2 below:

Table 2 – Observation records of large mammal species at Nara Wetland Complex

S. No	Species	Direct Observation	Indirect Observation		
			Foot prints	Fecal material	Interviews with locals
1	Asiatic jackal	✓	-	-	✓
2	Jungle cat	✓	-	-	✓
3	Fishing cat	-	✓	-	-
4	Desert cat	-	-	-	✓
5	Red fox	✓	✓	✓	✓
6	Smooth coated otter	-	-	-	✓
7	Small Indian mongoose	✓	-	-	✓
8	Grey mongoose	✓	-	-	✓
9	Hog Deer	-	✓	✓	✓
10	Indian wild boar	✓	-	-	✓

3.1.4 Conservation Status of Recorded Mammals

Out of the 10 recorded species, one is Endangered, two Vulnerable (VU) and seven Least Concern (LC) according to the IUCN Red List 2011. Hog Deer is listed in Appendix of

CITES and Jungle Cat and Fishing Cat in Appendix II of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix I of CITES lists species that are the most endangered and CITES prohibits international trade in specimen of these species. Appendix II lists the species that are not threatened now but may become so unless trade is closely controlled.

Table 3 – Conservation status of mammals found at Nara Wetland Complex

S. No	Mammalian Species Recorded from Nara Wetland Complex	IUCN Red List 2011	Sindh Wildlife Protection Ordinance 1972	CITES Category 2011
1	Asiatic jackal	LC	-	-
2	Jungle cat	LC	P	Appendix II
3	Fishing cat	VU	P	Appendix II
4	Desert cat	LC	P	Appendix II
5	Red fox	LC	-	-
6	Smooth coated otter	VU	P	Appendix II
7	Small Indian mongoose	LC	-	-
8	Grey mongoose	LC	-	-
9	Hog Deer	E	P	Appendix I
10	Indian wild boar	LC	-	-

Legend: E = Endangered, VU = Vulnerable, LC = Least Concern, P = Protected

3.1.5 Key Mammalian Species

No mammalian species is endemic to the area. Out of the ten species recorded from the area, the following two species can be considered as the key species which have a limited habitat in the area.

Hog Deer: The species is categorized as 'Endangered' in the IUCN Red List 2011. The species is facing risk of extinction in Pakistan in its entire range, mainly due to threats to its habitat. It was distributed in the riverine forests in Sindh and Punjab but vanishing from its habitat. The habitat is degrading due to reduction in water flow and clearing of forest for agriculture extension.

In Nara, it is reported that a scattered population of about 30 animals exists. About 10 – 15 animals of this population are concentrated in dense vegetation along the Nara Canal between RD 424 to RD 463 of the Canal (Halcrow 2001).

Furthermore, a population of 120 – 130 Hog Deer exists in the private game reserve of Mir Ali Murad Khan Talpur in Koho Kawanwaro in an area of approximately 557 acres.

It has also been reported that there are two small pockets in the north of Koho Kawanwaro and west of Nara canal *i.e.* Keith Mohari and Peeran Pattan that support three and six animals respectively (Halcrow 2001).

Smooth-coated Otter: It has been assessed as vulnerable by IUCN Red List of Threatened Species (2011) and listed in Appendix II of the CITES. AS per IUCN Red List of Mammals of Pakistan, it has been assessed as 'Near Threatened' (Sheikh and Molur, 2005).

It has been previously reported in Sindh from lower Indus valley and Nara Canal area. Lately, it was perceived as extinct in most of its distribution range in Sindh. Recently, Khan et al. (2010) confirmed its occurrence in Chotiari Wetland Complex, Nara Canal Area, Keenjhar Lake and Keti Shah Riverine Forest. The major threats to the species are – deterioration of its habitats, hunting for its skin and being considered a threat to the fish stock.

3.1.6 Threats and recommendations

3.1.6.1 Threats

- Hunting: Hunting for recreation is common and uncontrolled. Though the area is protected but there is no effective implementation of the wildlife laws. This is also leading to imbalance between predator and prey species.
- Grazing of Livestock: The excessive grazing of livestock together with recent climatic changes is degrading the ecosystem dynamics.
- Cutting of trees: The felling of trees in the adjoining desert for conversion into agricultural fields is affecting the faunal population in the process.
- Developmental activities: Increasing human population and habitation, developmental activities in the area and conversion of land for agriculture purposes has been affecting the habitat and ultimately putting stress on the existing wildlife.

3.1.6.2 Recommendations

- Controlled hunting: The check posts may be established at important points for keeping vigilance on uncontrolled hunting. The Sindh Wildlife Department is short of staff and transport to check the hunting pressure. The authorities should consider strengthening of Sindh Wildlife Department in the area.
- Community based conservation tourism: Nara Wetland Complex site is a good site for promoting ecotourism. The watch towers at potential points for bird watching and other facilities need to be developed. The local community should be involved and benefited from this activity. The youth of the community may be trained as eco-guides. This will provide incentives to the local community as an income generating activity and an alternative livelihood source.

- Promote participatory wildlife management: The institutional capacity of community based organizations in the area for wildlife management and conservation needs to be developed.

3.2 Small mammals

3.2.1 Observation locations

Map 4 shows the sample locations for small mammals in Nara Wetland Complex. Details of observation points can be found in the annexure document.

Map 3 – Locations of observation of mammals at Nara Wetland Complex

3.2.2 Species recorded

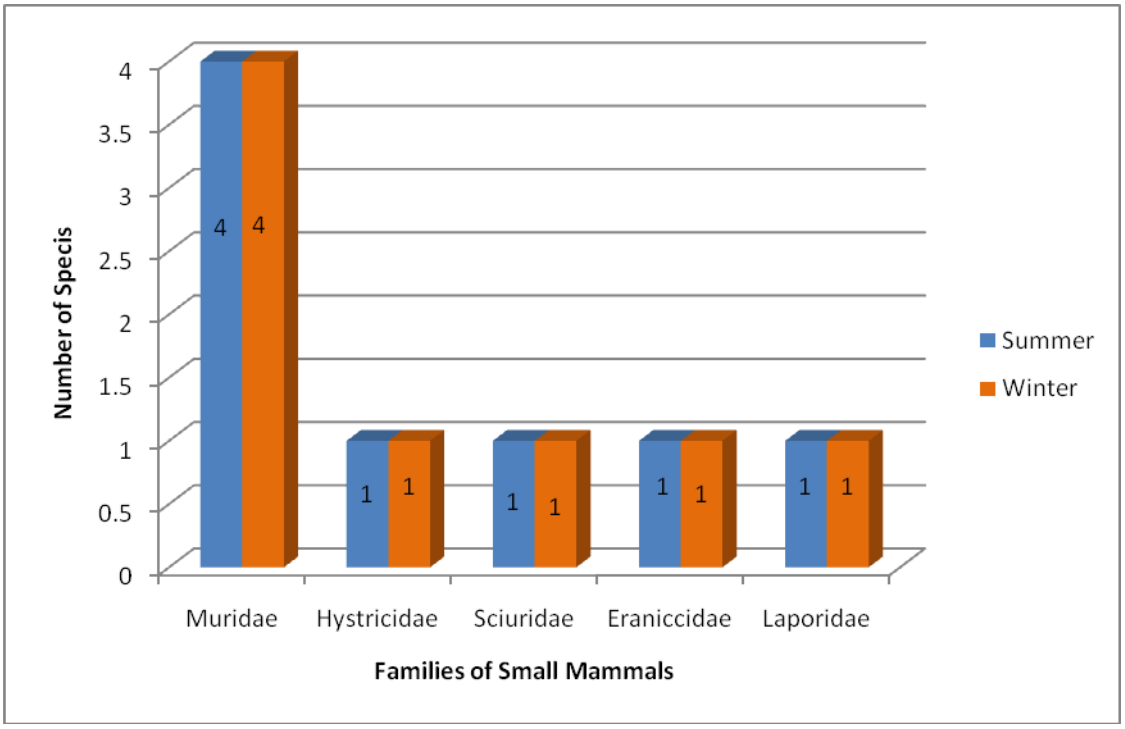
Eight species belonging to 3 orders (Rodentia, Insectivora and Lagomorpha) and 5 families (Sciuridae, Erinaceidae, Leporidae, Hystricidae and Muridae) were observed. Table 4 gives the species recorded at Nara Wetland Complex along with their conservation status, feeding habits and activity habits.

Table 4 – Species recorded at Nara Wetland Complex along with conservation status, feeding and activity habits

S. No	Scientific Name	English Name	Feeding Habit	Behavior	Status	Winter	Summer
1	*Funambulus pennanti*	Palm Squirrel	GRN	DR	C	8	8
2	*Gerbilus nanus*	Balochistan Gerbil	GRN	NC	C	4	6
3	*Hemiechinus collaris*	Long-eared Hedgehog	OMV	NC	SC	3	2
4	*Hystrix indica*	Indian crested porcupine	HRB	NC	C	4	7
5	*Lepus nigricollis*	Desert hare	HRB	NC	C	3	4
6	*Meriones hurrianae*	Indian Desert Jird	GRN	DR	SC	7	10
7	*Mus musculus*	House mouse	GRN	NC	C	5	3
8	*Tatera indica*	Indian Gerbil	GRN	NC	C	2	8

[Legend: GRN = Grainivore, HRB = Herbivore, OMN = Omnivore, C = Common, SC = Scarce]

Figure 1 – Family representation of recorded small mammals at Nara Wetland Complex



Habitats and feeding types

Nara Wetland Complex area contains diverse habitats such as open wetlands, shallow pools, aquatic margin vegetation, sand dunes, surrounding desert, agricultural fields that provide shelter for variety of small mammals. This is reflected by the number of species recorded both in winter and summer. As with most sites, Muridae was the most commonly represented family in this area and the remaining families were represented by one or two species. Figure 1 shows the number of species in each family.

Most of the species at Nara Wetland Complex were recorded from sandy areas. Figure 2 and 3 show the distribution of species by feeding habitats and number of species recorded from the main habitats surveyed.

Figure 2 – Distribution of feeding types by small mammal species recorded at Nara complex

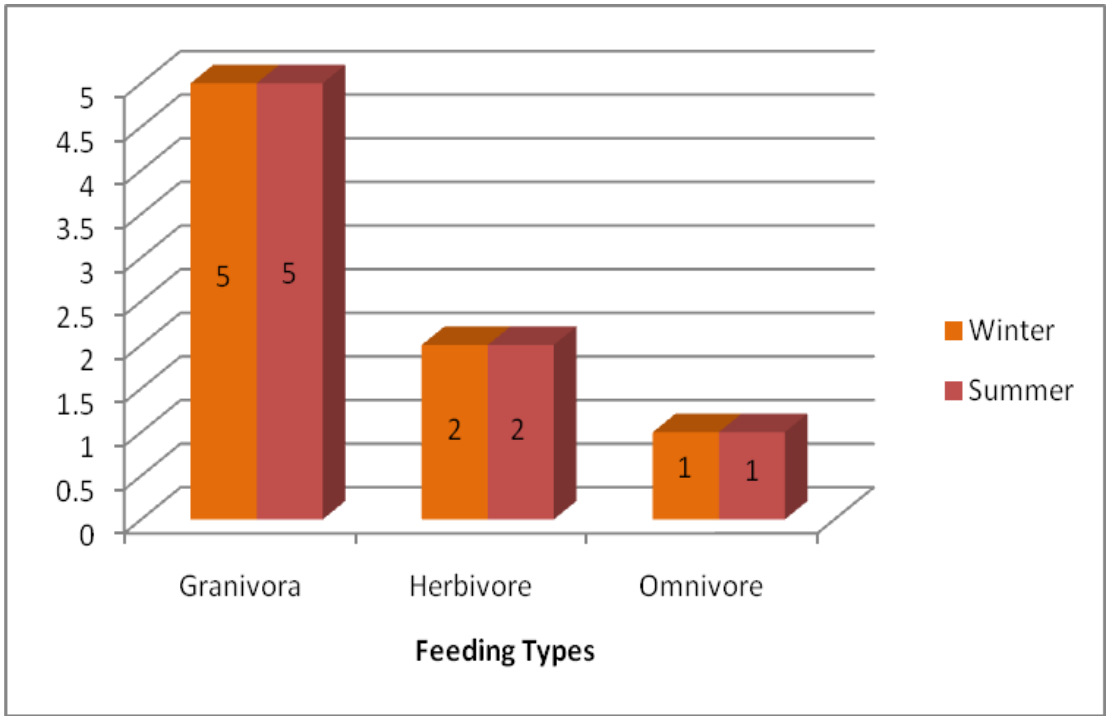
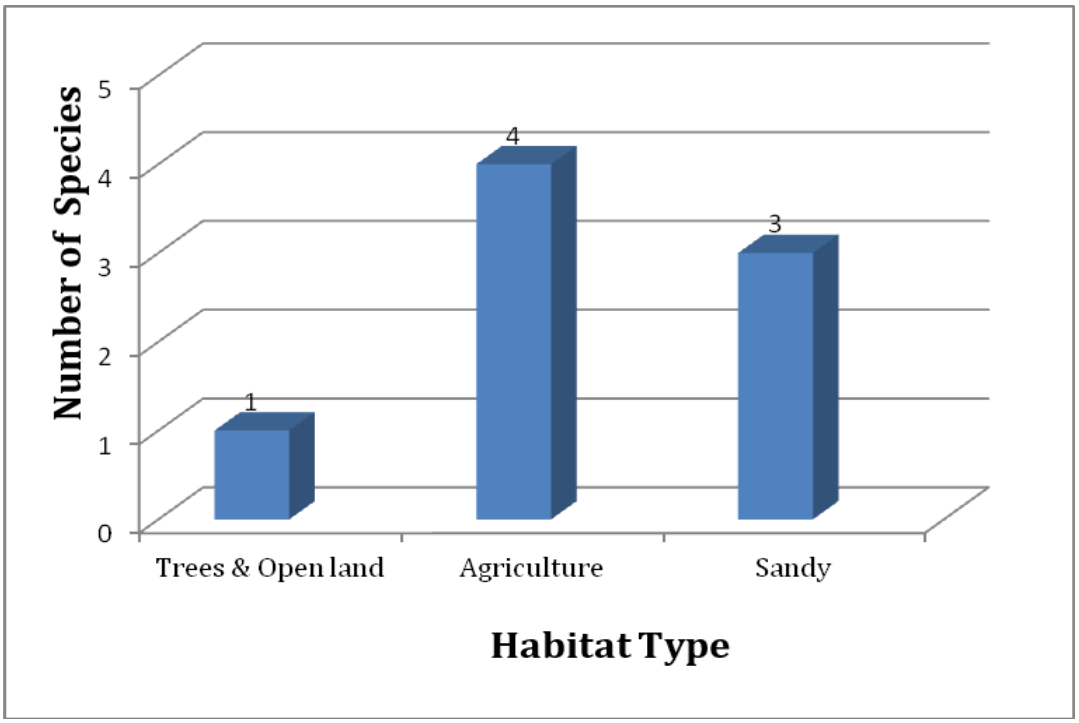


Figure 3 – Number of small mammal species recorded from main habitat types at Nara complex



Agriculture=4, Sandy=3, Trees & Open land=1

3.2.3 Threats and recommendations

3.2.3.1 Threats

- The inundation of the area in recent floods has affected the habitat and caused the decline in burrowing species.
- The development activities in the area are the cause of degradation of habitat. This is also leading to habitat fragmentation so population of some species can become fragmented.

3.2.3.2 Recommendations

- The Sindh Wildlife Department should monitor local small mammal populations around the canal and associated wetlands.
- The environmental education and awareness programme on importance of small mammals for local people and other stakeholders may be initiated.

3.3 Reptiles and Amphibians

3.3.1 Sample points

The Map given below shows the reptile and amphibian trapping locations in Nara Wetland Complex.

Map 4 – Sampling points of reptile and amphibian surveys at Nara complex

3.3.2 Summary

The Nara Wetland Complex can be delineated into distinct habitats viz. Desert scrub, Sand dunes, cultivated areas, water canal and associated wetlands.

Nara has a great significance pertaining to the natural history of herpeto-fauna. There is sizeable natural population of Marsh crocodile *(Crocodylus palustris)* in the Nara Canal (Rahman, 2006). The status, distribution and other details of this species are discussed in detail in the species account section.

3.3.3 Species account

The Nara Wetland Complex has diversified herpeto-fauna. The herpetofauna as recorded from the area is given in Table 5.

Table 5 List of reptilian fauna recorded from Nara

	English Name	**Scientific Name**	**Status**	**Activity Pattern**	**Feeding Habits**	**Summer**	**Winter**
Reptiles							
Order Crocodylia							
Family Crocodylidae							
1	Mugger Crocodile	*Crocodylus palustris*	UC	Not specific, mostly nocturnal	CAR	5	29
Order Chelonia							
Family Emydidae							
2	Saw-back Turtle	*Kachuga tecta*	C	Diurnal	HRB	2	2
3	Brown River Turtle	*Kachuga smithii*	C	Diurnal	CAR	1	1
Family Trionychidae							
4	Spotted Pond Turtle	*Geoclemys hamiltonii*	R	Diurnal	CAR	1	2

5	Indian Soft shell Turtle	*Aspiderestes gangeticus*	R	Nocturnal	HRB	2	1
6	Indian Flap-shell Turtle	*Lissemys punctata punctata*	R	Diurnal	CAR	1	1
Order Squamata							
Family Elapidae							
7	Indian Cobra	*Naja naja naja*	R	Nocturnal	CAR	8	2
Family Viperidae							
8	Saw-scaled Viper	*Echis carinatus*	C	Nocturnal	CAR	8	1
Family Boidae							
9	Indian Sand boa	*Eryx johnii*	R	Nocturnal	CAR	2	2
Family Colubridae							
10	Sind Awl-headed Sand Snake	*Lytorhynchus paradoxus*	R	Nocturnal	CAR	1	2
11	Cliff Racer	*Platyceps r. rhodorachis*	C	Diurnal	CAR	4	2
12	Glossy-bellied Racer	*Platyceps ventromaculatus*	C	Nocturnal	CAR	1	1
13	Checkered Keelback	*Xenochrophis piscator*	C	Winter-Diurnal; Summer-Crepuscular	CAR	10	5
Family Agamidae							
14	Tree Lizard	*Calotes v. versicolor*	C	Diurnal	INS	10	6
15	Afghan Ground Agama	*Trapelus megalonyx*	C	Diurnal	INS	6	2
Family Gekkonidae							
16	Yellow-bellied house gecko	*Hemidactylus flaviviridis*	C	Nocturnal	INS	4	1
17	Spotted Indian House Gecko	*Hemidactylus brookii*	A	Nocturnal	INS	4	2
18	Keeled Rock Gecko	*Cyrtopodion scaber*	R	Diurnal	INS	6	2
Family Scincidae							
19	Three-fingered Sand-fish	*Ophiomorus raithmai*	R	Nocturnal	INS	10	3
20	Indian Sand Swimmer	*Ophoimorus tridactylus*	C	Diurnal	INS	15	5
21	Bronze Grass Skink	*Eutrophis macularia*	C	Diurnal	INS	4	5

Family Varanidae							
22	Bengal Monitor	*Varanus bengalensis*	C	Diurnal	CAR	8	5
23	Desert Monitor	*Varanus griseus*	R	Diurnal	CAR	4	1
Family Lacertidae							
24	Indian fringe-toed Sandy Lizard	*Acanthodactylus cantoris*	C	Diurnal	INS	8	2
Order Anura							
Family Bufonidae							
25	Marbled toad	*Bufo stomaticus*	A	Non-specific	INS	20	15
Family Ranidae							
26	Bull frog	*Hoplobatrachus tigerinus*	C	Nocturnal	INS	15	12
27	Skittering Frog	*Rana cyanophlyctis*	C	Non-specific	INS	20	13

[Legend: HRB = Herbivore, OMN = Omnivore, C = Common, LC = Less Common, R = Rare]

3.3.3.1 Key Reptilian Species

Fourteen important lakes and several villages were surveyed during the surveys in December 2010 and July 2011 to record the reptilian and amphibian species. Surveys for both diurnal and nocturnal animals were conducted. A total of 24 species of reptiles belonging to 3 orders and 12 families and three species of amphibians belonging to two families were recorded. The *dhands* were particularly surveyed to explore the presence of marsh crocodile. According to feeding habit two were herbivorous, 13 carnivorous and 9 insectivorous reptiles; amphibians were all insectivores.

The lakes (*dhands*) which were surveyed include Dangewari dhand, Kharari dhand, Kinri dhand, Jari dhand, Kirchan dhand, Sanlo dhand, Nango pir dhand, Sim dhand, Luckial dhand, Akhero dhand, Samabi dhand, Dhalao dhand, Ber wari dhand and Munjarko dhand.

Marsh Crocodile is the key reptilian species of the area. During the survey on the following wetlands, 29 crocodiles were counted from different wetlands in December 2010 surveys in the area, as given in the following Table ??.

Table ??. ?????????????????????????????????????///

Name of Wetlands	Coordinates	No. of Crocodiles sighted

Akhero dhand	N 26 45 55.2 E 68 54 37.6	9
Berwari dhand	N 26 44 07.1 E 68 58 49.2	Nil
Dhangewari	N 27 00 42.3 E 68 59 16.9	Nil
Dholahoo dhand	N 26 43 02.9 E 68 56 27.1	Nil
Jageer dhand	N 26 54 18.8 E 68 00 16.3	Nil
Jari dhand	N 27 01 02.0 E 68 97 01.9	Nil
Kathor dhand	N 26 54 18.8 E 68 54 52.8	Nil
Kharari dhand	N 27 00 42.3 E 68 97 29.7	Nil
Kinri dhand	N 27 01 31.5 E 68 97 96	Nil
Kirchan dhand	N 27 05 34.2 E 68 99 96.0	2
Lalari dhand	N 26 40 10.0 E 68 57 58.3	3
Luckial dhand	N 26 44 53.3 E 68 54 37.6	Nil
Makan Wari	N 26 42 47.5 E 68 58 43.1	Nil
Munjarko dhand	N 26 44 07.1 E 68 59 33.4	Nil
Nangio pir dhand	N 26 43 35.0 E 68 62 32.8	8
Putkan dhand	N 26 42 25.6 E 68 59 04.9	Nil
Samabi dhand	N 26 45 18.2 E 68 53 32.4	7
Sim dhand	N 26 42 16.0 E 68 53 24.5	Nil
Simni dhand	N 26 44 06.9 E 68 58.48.9	Nil
Simno Wahid dhand	N 26 42 10.9 E 68 53 42.3	*25, reported
Sinlo dhand	N 27 09 43.1 E 68 97 74.4	Nil
	TOTAL	**29**

**Due to time constraint, the crocodiles could not be sighted at the wetland.*

Nara Wetland Complex has a great significance pertaining to the natural history of herpeto-fauna. There is a significant natural population of Marsh Crocodile in the Nara Canal and other sites inside Chotiari reservoir (Rahman, 2006). There are reports of occurrence of about 200 marsh crocodiles in Nara canal and associated wetlands, as gathered in personal communication with the locals. There is need of consistent monitoring in this area to determine the exact population.

Diversity Index and Evenness not calculated

3.4 Avifauna

3.4.1 Sampling points

The Map given below shows the observation points for bird surveys in Nara Wetland Complex.

Map 5 - Observation points of bird surveys in Nara Wetland Complex

3.4.2 Summary

Nara Wetland Complex has diverse habitats for birds, which includes lakes, marshes, desert, agriculture areas, fish ponds, wasteland and villages.

3.4.3 Species List

3.4.3.1 Winter and Summer

A total of 118 species of birds belonging to 13 orders and 35 families were recorded. Among them in winter, 118 species belonging to 13 orders and 35 families were recorded whereas in summer 61 species of birds belonging to 13 orders and 32 families were recorded. The total number of birds counted in winter was 6,864 and in summer it was 3,790. The results show that the number of species found in winter was greater than summer. The major reason for recording more species in winter and counting more birds could be the presence of migratory birds during winter.

Among the total species of birds recorded, 59 were resident, 53 winter visitors, 2 summer visitors, 2 passage migrants and 2 year round visitors. The status of birds found in the area was derived on the basis of its occurrence in this area denoting <5 as rare 6 to 15 as scarce and >15 as common. On the basis of the developed criteria, 71 species were common, 31 rare and 25 common.

The winter migrants start arriving in the area in late August and depart by April. As regards the breeding of birds in the area in summer, it requires further investigation and could not be observed in the brief survey.

Table 6 shows the birds species observed at Nara complex during winter.

Table 6 – List of bird species recorded from Nara Wetland Complex during winter and summer

	English name	Scientific name	Status	Occurrence	Count	
					Winter	Summer
Order Podicepidiformes						
Family Podicipedidae						
1.	Little Grebe	Tachybaptus ruficollis	Common	R	150	100
2.	Black-necked Grebe	Podiceps nigricollis	Rare	WV	4	-
Order Pelecaniformes						
Family Phalacrocoracidae						
3.	Little Cormorant	*Phalacrocorax niger*	Common	R	400	200
4.	Large Cormorant	*Phalacrocorax carbo*	Common	WV	370	-
5.	Indian Darter	*Phalacrocorax fuscicollis*	Rare	WV	5	-
Order Ciconiiformes						
Family Ardeidae						
6.	Grey Heron	*Ardea cinerea*	Scarce	WV	17	-
7.	Purple Heron	*Ardea purpurea*	Rare	R	2	2
8.	Indian Pond Heron	*Ardeola grayii*	Common	R	65	50
9	Cattle Egret	*Bubulcus ibis*	Common	R	10	40
10.	Large Egret	*Egretta alba*	Common	WV	30	-
11.	Intermediate Egret	*Egretta intermedia*	Common	R	68	10
12.	Little Egret	*Egretta garzetta*	Common	R	80	60
13.	Reef Heron	*Egretta gularis*	Common	R	35	20
14.	Little Bittern	*Ixobrychus minutus*	Common	R	35	-
15.	Yellow Bittern	*Ixobrychus sinensis*	Rare	R	4	-
Order Anseriformes						

Family Anatidae						
16.	Ruddy Shelduck	*Tadorna ferruginea*	Rare	WV	4	-
17.	Marbled Teal	*Marmaronetta angustirostris*	Scarce	WV	6	2
18.	Common Teal	*Anas crecca*	*Common*	*WV*	*240*	-
19.	Mallard	*Anas platyrhynchos*	Common	WV	32	-
20.	Gadwall	*Anas strepera*	Less Common	WV	20	-
21.	Shoveller	*Anas clypeata*	Common	WV	250	-
22.	Common Pochard	*Aythya ferina*	Common	WV	400	-
23.	Ferruginous Duck	*Aythya nyroca*	Rare	WV	22	-
24.	Tufted Duck	*Aythya fuligula*	Rare	WV	8	
Order Falconiformes						
Family Accipitridae						
25.	Blackwinged Kite	*Elanus caeruleus*	Scarce	R	7	2
26.	Common Kite	*Milvus migrans*	Common	R	16	25
27.	Brahminy Kite	Haliastur indus	Rare	R	4	-
28.	Central Asian Shikra	*Accipiter badius*	Rare	R	4	2
29.	White-eyed Buzzard	*Butastur teesa*	Rare	R	6	6
30.	Marsh Harrier	*Circus aeruginosus*	Common	WV	16	-
Family Falconidae						
31.	Common Kestrel	*Falco tinnunculus*	Rare	WV	4	-
Family Pandionidae						
32.	Osprey	*Pandion haliaetus*	Rare	WV	2	-
Order Galliformes						
Family Phasianidae						
33.	Grey Partridge	*Francolinus pondicerianus*	Common	R	113	90
34.	Black Partridge	*Francolinus francolinus*	Scarce	R	22	12
Order Gruiformes						
Family Rallidae						
35	White-breasted Waterhen	*Amaurornis phoenicurus*	Scarce	R	12	15
36.	Indian	*Gallinula*	Common	R	70	60

	Moorhen	*chloropus*				
37.	Purple Moorhen	*Porphyrio porphyrio*	Common	R	19	12
38.	Common Coot	*Fulica atra*	Common	WV	300	-
Order Charadriiformes						
Family Charadriidae						
39.	Greater Sand Plover	*Charadrius leschenaultia*	Rare	WV	4	-
40.	Redwattled Lapwing	*Vanellus indicus*	Common	R	60	80
41.	White tailed Plover	*Vanellus leucurus*	Common	WV	28	-
42.	Little Ringed Plover	*Charadrius dubius*	Scarce	WV	8	-
43.	Kentish Plover	*Charadrius alexandrinus*	Scarce	WV	6	-
44.	Lesser Sand Plover	*Charadrius mongolus*	Rare	WV	4	-
Family Scolopacidae						
45.	Curlew	*Numenius arquata*	Scarce	WV	6	-
46.	Whimbrel	*Numenius phaeopus*	Scarce	PM	7	-
47.	Bartailed Godwit	*Limosa lapponica*	Scarce	WV	8	-
48.	Common Redshank	*Tringa totanus*	Common	WV	31	-
49.	Marsh Sandpiper	Tringa stagnatilis	Scarce	WV	6	-
50.	Greenshank	Tringa nebularia	Scarce	WV	7	-
51.	Wood Sandpiper	Tringa glareola	Rare	WV	4	-
52.	Common Sandpiper	Tringa hypoleucos	Common	WV	38	-
53.	Common Snipe	Gallinago gallinago	Scarce	WV	6	-
54.	Little Stint	Calidris minutus	Common	WV	80	-
55.	Dunlin	Calidris alpine	Common	WV	28	2
56.	Ruff	Philomachus pugnax	Scarce	WV	130	-
Family Recurvirostridae						
57.	Blackwinged Stilt	Himantopus himantopus	Common	R	480	500
Family Laridae						
58.	Heuglin's Gull	Larus heuglini	Common	WV	20	-

59.	Brownheaded Gull	*Larus brunnicephalus*	Scarce	WV	8	-
60.	Blackheaded Gull	*Larus ridibundus*	Common	WV	30	-
61.	Slenderbilled Gull	*Larus genei*	Scarce	R	12	-
62	Gull-billed Tern	*Gelochelidon nilotica*	Scarce	WV	12	-
63.	Caspian Tern	*Hydroprogne caspia*	Common	YRV	25	35
64.	Indian River Tern	*Sterna aurantia*	Scarce	R	16	10
65.	Blackbellied Tern	*Sterna acuticauda*	Rare	R	3	-
66.	Little Tern	*Sterna albifrons*	Common	R	30	25
67.	Sandwich Tern	*Sterna sandvicensis*	Rare	YRV	8	-
Order Columbiformes						
Family Columbidae						
68.	Blue Rock Pigeon	*Columba livia*	Common	R	32	50
69.	Ring Dove	*Streptopelia decaocto*	Common	R	330	600
70.	Little Brown Dove	*Streptopelia senegalensis*	Common	R	240	350
Order Cuculiformes						
Family Cuculidae						
71.	Crow Pheasant	*Centropus sinensis*	Common	R	48	20
Order Strigiformes						
Family Strigidae						
72.	Brown Fish owl	*Ketupa zeylonensis*	Rare	WV	2	-
73.	Spotted Owlet	*Athene brama*	Rare	R	9	6
Order Coraciiformes						
Family Alcedinidae						
74.	Pied Kingfisher	*Ceryle rudis*	Common	R	37	20
75.	Common Kingfisher	*Alcedo atthis*	Rare	R	4	2
76.	Whitebreasted Kingfisher	*Halcyon smyrnensis*	Common	R	33	60
Family Meropidae						
77.	Green Bee-eater	*Merops orientalis*	Common	R	40	33
78.	Blue-cheeked	*Merops persicus*	Common	SBV	-	30

	Bee-eater					
Family Coracidae						
79.	Indian Roller	*Coracias benghalensis*	Common	R	30	15
Family Upupidae						
80.	Common Hoopoe	*Upupa epops*	Rare	WV	8	6
Order Passeriformes						
Family Alaudidae						
81.	Desert Lark	*Amomanes deserti*	Scarce	R	12	8
82.	Great Short-toed Lark	*Calendrella brachydactyla*	Rare	WV	5	-
83.	Crested Lark	*Galerida cristata*	Common	R	125	90
Family Hirundinidae						
84.	Pale Sand Martin	*Riparia diluta*	Common	WV	23	-
85.	Crag/Rock Martin	*Hirundo fuligula*	Rare	R	4	-
86.	Barn or Common Swallow	*Hirundo rustica*	Common	WV	200	100
Family Laniidae						
87.	Rufous tailed or Isabelline Shrike	*Lanius isabellinus*	Scarce	WV	15	-
88.	Southern Grey Shrike	*Lanius meridionalis*	Common	R	18	16
89.	Bay backed Shrike	*Lanius vittatus*	Scarce	R	6	6
Family Dicruridae						
90.	Black Drongo	*Dicrurus adsimilis*	Common	R	52	30
Family Sturnidae						
91.	Indian Myna	*Acridotheres adsimilis*	Common	R	157	200
92.	Common Starling	*Sturnus vulgaris*	Scarce	WV/R	10	4
Family Muscicapidae						
93.	Black Redstart	*Phoenicurus ochruros*	Rare	WV	7	-
94.	Hume's Wheatear	*Oenanthe albonigra*	Common	R	25	30
95.	Indian Robin	*Saxicoloides fulicata*	Common	R	28	10

96.	Pied Bush Chat	*Saxicola caprata*	Common	R	18	12
97.	Isabelline Wheatear	*Oenanthe isabellina*	Scarce	WV	6	-
98.	Desert Wheatear	*Oenanthe deserti*	Common	WV	8	-
Family Corvidae						
99.	House Crow	Corvus splendens	Common	R	58	20
100.	Tree Pie	Dendrocitta vagabunda	Scarce	R	6	2
Family Cisticolidae						
101.	Yellow bellied Prinia	Prinia flaviventris	Common	R	10	15
102.	Rufous vented Prinia	Prinia burnesii	Common	R	17	20
Family Pycnonotidae						
103.	White-cheeked Bulbul	Pycnonotus leucogenys	Common	R	54	60
104.	Red vented Bulbul	Pycnonotus cafer	Scarce	R	18	12
Family Timaliidae						
105.	Common Babbler	Turdoides caudatus	Common	R	159	60
106.	Striated Babbler	Turdoides earlie	Rare	R	4	2
107.	Jungle Babbler	Turdoides striata	Common	R	235	50
Family Rhipiduridae						
108.	White browed Fantail Flycatcher	Rhipidura aureola	Scarce	R	7	6
Family Sylviidae						
109.	Common Chiffchaff	*Phylloscopus collybita*	Common	WV	20	-
110.	Clamorous Reed Warbler	*Acrocephalous stentoreus*	Rare	PM	3	15
111.	Lesser Whitethroat	*Sylvia curruca*	Common	WV	25	-
112.	Common Chiffchaff	*Phylloscopus collybita*	Common	WV	37	-
113.	Greenish Warbler	*Phylloscopus trochiloides*	Rare	WV	4	-
Family Motacillidae						
114.	White Wagtail	*Motacilla alba*	Common	WV	67	-
115.	Yellow Wagtail	*Motacilla flava*	Common	PM	41	-

Family Nectarinidae						
116.	Purple Sunbird	*Nectarinia asiatica*	Common	R	30	20
Family Passeridae						
117.	House Sparrow	*Passer domesticus*	Common	R	100	200
118.	Sind Jungle Sparrow	*Passer pyrrhonotus*	Common	R	480	300
			TOTAL		**6944**	**2646**

Legend: R = Resident, WV = Winter visitor, PM = Passage Migrant, YRV = Year Round visitor

3.4.4 Winter and summer comparison

The winter surveys in the area were undertaken during November 2010 and summer surveys in July 2011.

Figure 4 – Number of species, families and orders observed during winter and summer season

Figure 5 – The abundance of the number of species during summer and winter seasons

Figure 6 – Representation of birds recorded during summer and winter seasons

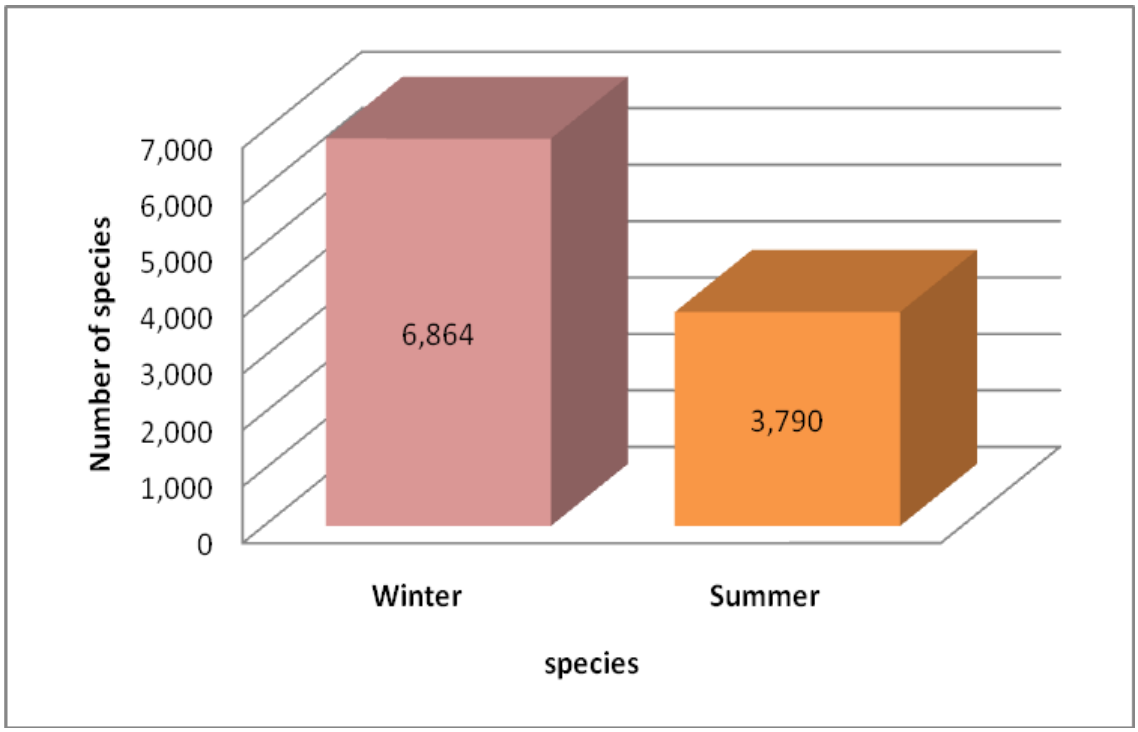
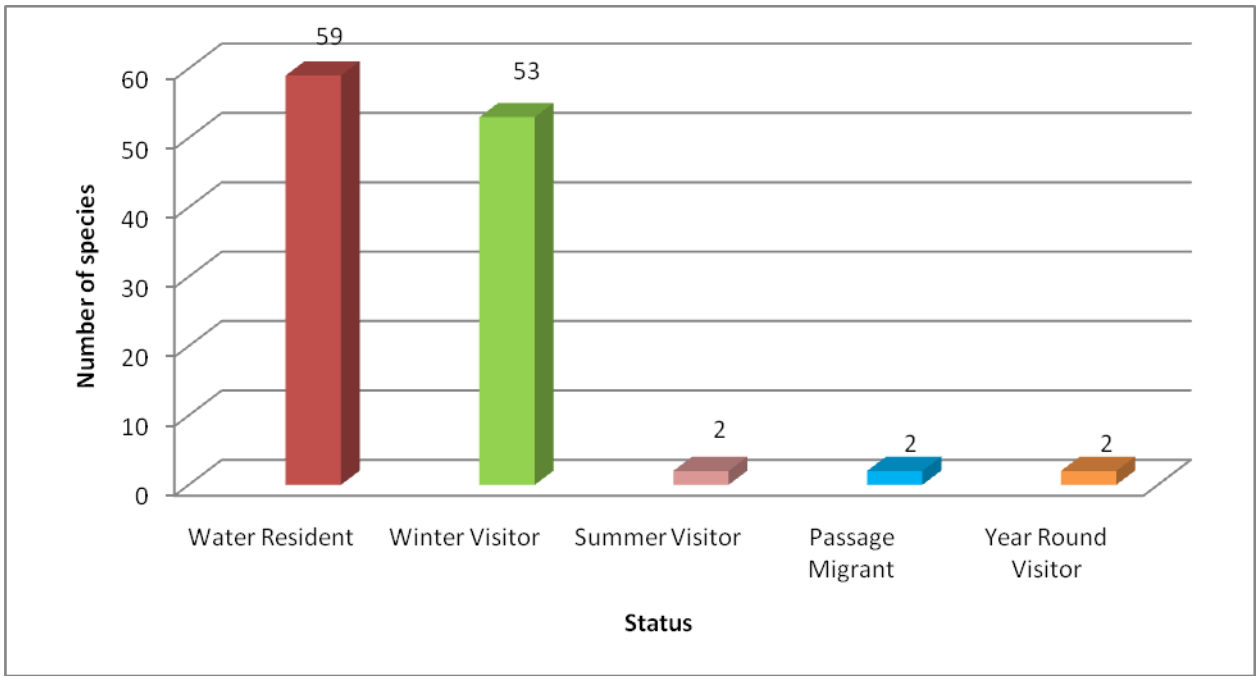


Figure 7 – Number of bird species recorded from Nara Wetland Complex by seasons and occurrence



3.4.5 Conservation status

Table 7 shows the conservation status of bird species recorded in Nara Wetland Complex.

Table 7 Conservation status of bird species recorded in Nara Wetland Complex

Species of Bird Recorded from Nara Wetland Complex	*IUCN Red List 2011	**Sindh Wildlife Protection Ordinance 1972	***CITES Category 2011	****CMS [effective 5 March 2009]
Grey Heron	LC	Schedule II		
Purple Heron	LC	Schedule II		
Indian Pond Heron	LC	Schedule II		
Cattle Egret	LC	Schedule II	Appendix III	
Large Egret	LC	Schedule II	Appendix III	
Intermediate Egret	LC	Schedule II	Appendix III	
Little Egret	LC	Schedule II	Appendix III	
Reef Heron	LC	Schedule II		
Little Bittern	LC	Schedule II		
Yellow Bittern	LC	Schedule II		
Ruddy Shelduck	LC	Schedule II	Appendix II	
Marbled Teal	V	Schedule II		Appendix I

Common Teal	LC	Schedule I	Appendix III	
Mallard	LC	Schedule I	Appendix I	
Gadwall	LC	Schedule I		
Shoveller	LC	Schedule I	Appendix III	
Common Pochard	LC	Schedule I		
Ferruginous Duck	NT	Schedule II	Appendix III	Appendix I
Tufted Duck	LC	Schedule I		
Blackwinged Kite	LC	Schedule II	Appendix III	
Brahminy Kite	LC	Schedule II		
Central Asian Shikra	LC	Schedule II		
White-eyed Buzzard	LC	Schedule II		
Marsh Harrier	LC	Schedule II		
Common Kestrel	LC	Schedule II	Appendix II	
Osprey	LC	Schedule II		
Grey Partridge	LC	Schedule II	Appendix III	
Black Partridge	V	Schedule II	Appendix III	
White-breasted Waterhen	LC	Schedule I		
Indian Moorhen	LC	Schedule I		
Purple Moorhen	LC	Schedule I		
Common Coot	LC	Schedule I		
Oystercatcher	LC	Schedule I		
Redwattled Lapwing	LC	Schedule I		
White tailed Plover	LC	Schedule I		
Little Ringed Plover	LC	Schedule I		
Kentish Plover	LC	Schedule I		
Lesser Sand Plover	LC	Schedule I		
Curlew	NT	Schedule I		
Whimbrel	LC	Schedule I		
Bartailed Godwit	LC	Schedule I		
Common Redshank	LC	Schedule I		
Marsh Sandpiper	LC	Schedule I		
Greenshank	LC	Schedule I		
Wood Sandpiper	LC	Schedule I		
Common Sandpiper	LC	Schedule I		
Common Snipe	LC	Schedule I		
Little Stint	LC	Schedule I		
Dunlin	LC	Schedule I		
Ruff	LC	Schedule I		
Blackwinged Stilt	LC	Schedule I		
Crab Plover	LC	Schedule I		
Heuglin’s Gull	LC	Schedule I		
Brownheaded Gull	LC	Schedule I		
Blackheaded Gull	LC	Schedule I		
Slenderbilled Gull	LC	Schedule I		
Caspian Tern	LC	Schedule I		

Blackbellied Tern	NT	Schedule I		
Little Tern	LC	Schedule I		
Sandwich Tern	LC	Schedule I		
Blue Rock Pigeon	LC			
Ring Dove	LC			
Little Brown Dove	LC			
Brown Fish owl	LC			
Spotted Owlet	LC	Schedule II	Appendix II	

Legend/Explanation:
**NT = Near Threatened, V = Vulnerable, LC = Least Concern*
***Schedule I =Animals which may be hunted on ordinary license; Schedule II=Protected Animals*
****Appendix I=Species that are most endangered; Appendix II=Species that may become threatened unless trade is closely controlled; Appendix III= species that needs cooperation of other countries to prevent unsustainable or illegal exploitation*
*****Appendix I=Danger of extinction*

3.4.6 Key Bird Species

No Bird species is endemic to the area. Marbled Teal may be considered as key bird species found in the area due to its limited range of distribution. The species is 'Protected' under Sindh Wildlife Protection Ordinance 1972 and also included in Appendix I of CMS (Bonn Convention).

The species prefers water bodies with vegetative cover having reeds and bushes. Marbled Teal is categorized as 'Vulnerable' under IUCN Red list 2011.

Other key species include Houbara Bustard, Ferruginous Duck, Indian Darter, Ruddy Shelduck, Black Ibis, Greater Flamingo, Grey Partridge, Blue-cheeked Bee-eater and Rosy Starling.

Akanwari Lake (N 270440.5, E 685557.2) turned out to be the most important wetland of the area for supporting 6,640 water birds during Asian Water birds Count 2011.

3.4.7 Habitat

The habitat around the Nara canal is ideal for birds, particularly the wetlands, desert scrub and the agricultural fields. The desert wetlands are the habitat of critical importance for the migratory water birds.

3.4.8 Threats and recommendations

3.4.8.1 Threats

- Hunting is one of the major threats to the bird fauna, especially in winter when large numbers of migratory birds are hunted.
- Habitat degradation is also a threat.

3.5 Physico-chemical Properties of Water

3.5.1 Sample Location

Samples were collected randomly from two dhands viz. Dangi war and Lake Nagio pur in Nara Wetland Complex. Map given below shows the sampling location of water quality for Wetlands of Nara

3.5.2 Field Observations during water sampling

Nara canal, its tributaries and the *dhand*s are the source of surface water. Water quality in areas along and recharged by the Nara canal is generally sweet. Ground water is found in sufficient quantity in areas along the Nara canal. The source of *dhands* is seepage water from Nara canal and surfacing of shallow ground water. The canal and its irrigation system have the largest Cultivated Command Area in the country (Halcrow 2001).

Several community tube wells are present in the area and water is used by the community for domestic purposes. Water table varies with the discharge in the canal and the amount of precipitation in the area.

3.5.3 Results

The collected water sample was analysed in the Laboratory of GEL Pvt Ltd. The analysis was completed on 30 may 2011. The result of the analysis of water of Lake Dangiwari is given in Table below:

Table 8- Analysis result of analysis of lake Dangiwari

S. No	Parameters	Unit	NSDWQ	Concentration	Method	Remarks
1	pH value		6.5 – 8.5	8.06	pH meter	
2	Chloride	mg/l	>250	26.2	APHA 4500 Cl C	
3	Conductivity	µS	-	316	Conductivity meter	
4	Turbidity	NT	5	16	Merck	Higher

		U			Method (077)	
5	Total Hardness	mg/l	<500	153.9	APHA 2340 C	
6	Total Alkanity	mg/l	-	118.3	APHA 2320 B	
7	Cr (Hexa)	mg/l	0.05	0.02	Hach Method 8023	
8	Lead	mg/l	<0.05	BDL	AAS	
9	Zn	mg/l	5.0	BDL	AAS	
10	COD	mg/l	-	BDL	Hach Method 8000	
11	Iron	mg/l		BDL	AAS	
12	As	mg/l	<0.05	BDL	Merck Test (1,17927)	

Legend: NSDWQ = National Standards for Drinking Water Quality
BDL = Below Detection Limit

Table 9 - The result of the analysis of water of Lake Nagi pur

S. No	Parameters	Unit	NSDWQ	Concentrations	Method	Remarks
1	pH value		6.5 – 8.5	8.58	pH meter	
2	Chloride	mg/l	>250	153.7	APHA 4500 Cl C	
3	Conductivity	µS	-	1652	Conductivity meter	
4	Turbidity	NTU	5	10	Merck Method (077)	Higher
5	Total Hardness	mg/l	<500	378.3	APHA 2340 C	
6	Total Alkanity	mg/l	-	525.0	APHA 2320 B	
7	Cr (Hexa)	mg/l	0.05	BDL	Hach Method 8023	
8	Lead	mg/l	<0.05	BDL	AAS	
9	Zn	mg/l	5.0	BDL	AAS	
10	COD	mg/l	-	BDL	Hach	

					Method 8000	
11	Iron	mg/l		BDL	AAS	
12	As	mg/l	<0.05	BDL	Merck Test (1,17927)	

Legend: NSDWQ = National Standards for Drinking Water Quality
BDL = Below Detection Limit

CHAPTER 4: COMPARISON OF THE FOUR STUDY SITES

Mammals

Summary:

There are no significant difference in results of the summer and winter surveys of the study areas. The same 13 species were recorded from the study areas during both the winter and summer surveys. Moreover, most of the mammals particularly the nocturnal mammals were found more active during the summer surveys and the less active comparatively during the winter surveys. The reasons seem to be the homoeothermic and the hibernation factors for less activeness of mammals during winter.

The population estimation of animals was not attempted during this preliminary study. Estimating population of mammals required large efforts and maximum time which was inadequate.

Habitat loss and natural disasters affect wildlife species but the mammalian fauna of the area is facing serious threats from anthropogenic activities. The apparent low abundance of many large mammalian species is strong evidence that hunting and habitat degradation is having a considerable effect on their population.

A few wildlife species also create problems for the local people and thus are considered as problem species. The major concerns about wild animals in different sites are the damages to crops through agricultural pests like wild boar and porcupine and threats to human lives from mad / feral dogs and snake bites.

Some socio-economic issues like un- employment, less education, lack of awareness, less availability of basic needs eta. At different sites are also important factors in wildlife conservation and management in the study area.

Species identified

During surveys a total of 13 large and medium sized mammal species belonging to three orders (Carnivora, Artiodactyla, and Pholidata) were recorded from the four sites.
Ten species were recorded from Nara Wetland Complex, five from Manchhar, ten species from Kharochann and seven from Khyberani Forest.

Table 10- Species recorded from different sites

S.No	Common Name	Zoological Name	Local Name	Order
1	Asiatic Jackal	*Canis aureus*	Giddar	Carnivora
2	Jungle Cat	*Felis chaus*	Jang Billo	Carnivora
3	Fishing Cat	*Prionailurus viverrinus*	Mash Billo	Carnivora
4	Indian Desert Cat	*Felis sylvestris ormata*	Sahrai Billi	Carnivora

5	Bengal Fox	*Vulpes bengalensis*	Lumar	Carnivora
6	Desert Fox or Red Fox	*Vulpes vulpes pusilla*	Sahrai Lumar	Carnivora
7	Smooth coated Otter	*Lutrogale perspicillata*	Ludher	Carnivora
8	Small Indian Mongoose	*Herpestes javanicus*	Neola	Carnivora
9	Grey Mongoose	*Herpestes edwardsi*	Neola	Carnivora
10	Small Indian Civet	*Viverricula indica*	Kasturi Billa	Carnivora
11	Hog Deer	*Axis porcinus*	Para	Artiodactyla
12	Indian Wild boar	*Sus scrofa*	Suar	Artiodactyla
13	Indian Pangolin	*Manis crassicaudata*	Bagra, Silu	Pholidota

Observation records:

Out of the total 13 recorded species, 6 species were observed directly while the remaining 7 species were recorded on the basis of indirect evidences such as the presence of fecal materials, foot prints and interviews of local residents and wildlife watchers. The observation records of different mammals found in all the five sites are given in the Table 11.

Table 11: Observation record of Large Mammals

S. No.	Species	Direct Observations				Indirect observations through tracks, feces and interviews from local people			
		NWC	ML	KC	KF	NWC	ML	KC	KF
	Asiatic Jackal	✓	✓	✓	✓	✓	✓	✓	✓
	Jungle Cat	✓	✓	✓	✓	✓	✓	✓	✓
	Fishing Cat					✓		✓	
	Desert Cat					✓		✓	
	Bengal fox					✓		✓	✓
	Red fox	✓	✓			✓	✓		
	Smooth coated otter					✓			
	Small Indian Mongoose	✓	✓	✓	✓	✓	✓	✓	✓
	Grey Mongoose	✓	✓	✓	✓	✓	✓	✓	✓
	Small Indian Civet							✓	
	Indian Wild boar	✓		✓	✓	✓		✓	✓
	Hog Deer					✓			✓
	Indian Pangolin							✓	

Legend: NWC = Nara Wetland Comlex, ML = Manchar Lake, KC = Kharochann, KF = Khyberani Forest

Conservation status of mammal species

According to IUCN International Red List 2011, Asiatic Jackal, Jungle Cat, Desert Cat, Bengal Fox, Red Fox, Grey Mongoose, Small Indian Civet, Indian Wild Boar are categorized as Least Concern (LC), Fishing Cat, Smooth Coated Otter, Small Indian Mongoose as Vulnerable (VU), Hog Deer as Endangered (EN) and Indian Pangolin as Near Threatened (NT).

Seven species are protected in Sindh under Sindh Wildlife Protection Ordinance 1972. Six species are enlisted in Appendix II while three species in Appendix I of the CITES category 2011. The conservation status of different mammals found at Indus for All Programme sites is given in Table 35 below.

Table 12 Conservation status of mammals found at sites

S.NO	Mammalian Species Recorded	IUCN Red List 2011	Sindh Wildlife Protection Ordinance 1972	CITES Category 2011
1	Asiatic Jackal	LC	-	-
2	Jungle Cat	LC	P	Appendix II
3	Fishing Cat	VU	P	Appendix II
4	Desert Cat	LC	P	Appendix II
5	Bengal Fox	LC	-	Appendix I
6	Red Fox	LC	-	
7	Smooth coated Otter	VU	P	Appendix II
8	Small Indian Mangoose	VU	-	Appendix II
9	Grey Mangoose	LC	-	
10	Small Indian Civet	LC	P	Appendix I
11	Indian Wild Boar	LC	-	
12	Hog Deer	EN	P	Appendix I
13	Indian Pangolin	NT	P	Appendix II

Legends: EN= Endangered, VU= Vulnerable, NT= Near Threatened, LC= Least Concern

Species Diversity

Looking at the diversity index over the four sites Nara Wetland Complex and Kharochann holds the highest level of diversity of mammals followed by Khebrani Forest. Given the variety of habits at Nara Wetland Complex (desert, wetland and forest) it is not surprising that this site holds the highest index. Similarly Kharochann comprises of both terrestrial and marine habitats which results in a high diversity index despite apparent environment degradation both inland and in the creeks. Even with some variance in diversity the evenness of diversity across the sites is quite regular, except for Nara Complex. These indexes do not take into account the diversity across seasons, something that is discussed further on in this chapter.

Comparison of Species observed during summer and winter

Number of animals recorded during summer and winter surveys are merely rough estimates and not the actual populations (Shown in Table 13 - 16). The last column in the following tables showing total animals is not reflecting the total population of different species at different sites. Rather it is just the sum of observed animals observed during summer might be the same counted or observed during winter.

Table 13 Mammals observed at Nara Wetlands Complex during summer and winter Surveys

S.NO	Common Name	Winter	Summer	Total Animals
1	Asiatic Jackal	4	1	5
2	Jungle Cat	1	-	1
3	Red Fox	1	-	1
4	Small Indian Mongoose	5	5	10
5	Grey Mongoose	3	1	4
6	Indian Wild Boar	4	-	4

Table 14 Mammals observed at Khyberani Forest during summer and winter surveys

S.NO	Common Name	Winter	Summer	Total Animals
1	Asiatic Jackal	5	2	7
2	Jungle Cat	1	-	1
3	Small Indian Mongoose	2	2	4
4	Grey Mongoose	1	-	1
5	Indian Wild Boar	3	-	3

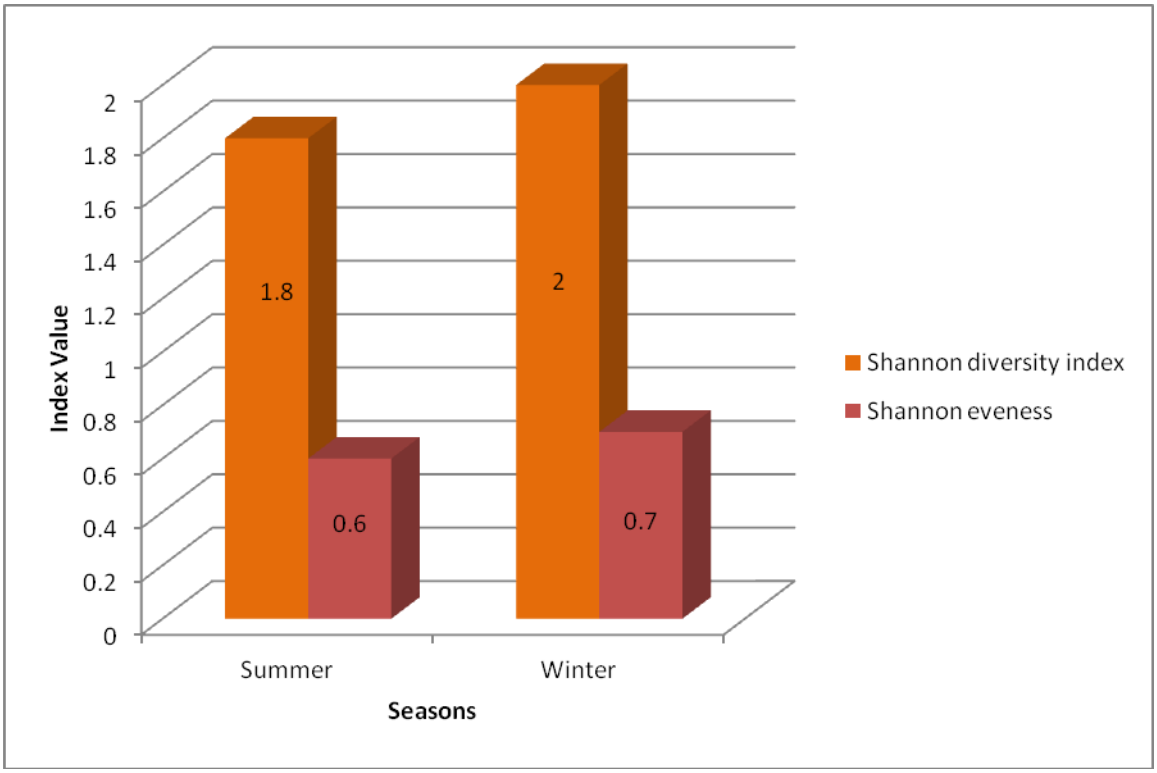
Table 15 Mammals observed at Manchhar Lake during summer and winter surveys

S.NO	Common Name	Winter	Summer	Total Animals
1	Asiatic Jackal	2	-	2
2	Jungle Cat	1	-	1
3	Small Indian Mongoose	1	1	2
4	Grey Mongoose	1	-	1

Table 16 Mammals observed from Kharochann during summer and winter surveys

S.NO	Common Name	Winter	Summer	Total Animals
1	Asiatic Jackal	3	-	3
2	Jungle Cat	1	-	1
3	Small Indian Mongoose	3	2	5
4	Grey Mongoose	1	-	1
5	Indian Wild Boar	4	-	4
6.	Indian Pangolin	1	-	1

Figure 8- Shannon diversity and Evenness index over all sites for summer and winter



There was more diversity of medium and large mammals in winter than summer across the four sites. There may be several reasons for this such as mammals were more active in winter foraging for food or were more detectable due to less vegetation on the ground.

Population Estimation

Populations of large mammals were not estimated as sufficient data in this respect could not be collected.

Assessment of level of threats to mammals at different study sites

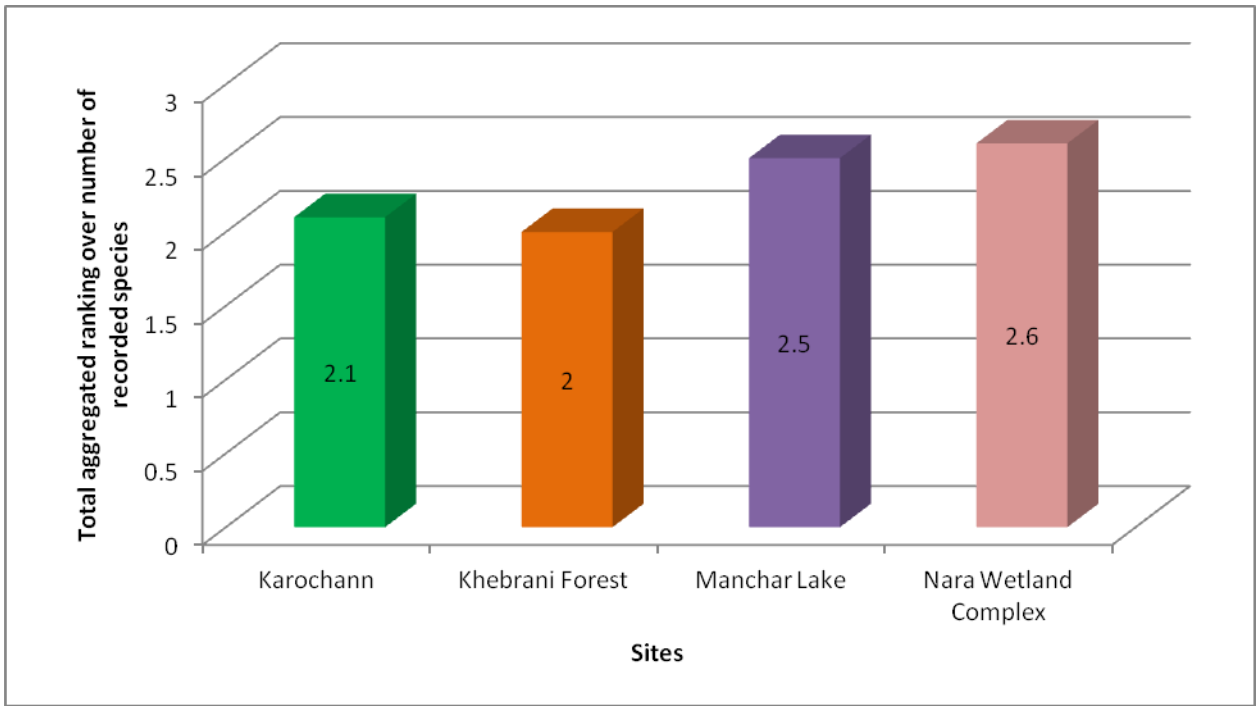
Various threats to different mammals were identified at four different study sites that include; habitat destruction, illegal hunting, poaching, live trapping, food competition, lack of awareness, law and order situation, weak enforcement of wildlife laws etc. Based on indirect and direct observations in the field and after interviewing different people from local communities and wildlife watchers and forest guards an assessment was made to indicate the level of threats to every mammal species iin four sites.

1= no threats, 2= minor threats, 3= moderate threats, 4= highly threatened, 5= critically threatened

Table 17 Assessment of level of threats to mammals at different study sites

S.No	Common Name	Kharochann	Khyberani Forest	Manchar Lake	Nara Wetland Complex
1	Asiatic Jackal	2	2	2	2
2	Jungle Cat	2	2	3	3
3	Fishing Cat	3	-	-	3
4	Indian Desert Cat	3	-	-	3
5	Bengal Fox	3	2	2	-
6	Desert Fox or Red Fox	3	-	2	3
7	Smooth coated otter	-	-	-	5
8	Small Indian Mongoose	1	1	1	1
9	Grey Mongoose	1	1	1	1
10	Small Indian Civet	3	-	-	-
11	Hog Deer	-	5	-	4
12	Indian Wild Boar	1	1	-	1
13	Indian Pangolin	3	-	-	-

Figure 9 Aggregated threat ranking adjusted against number of species recorded from each site



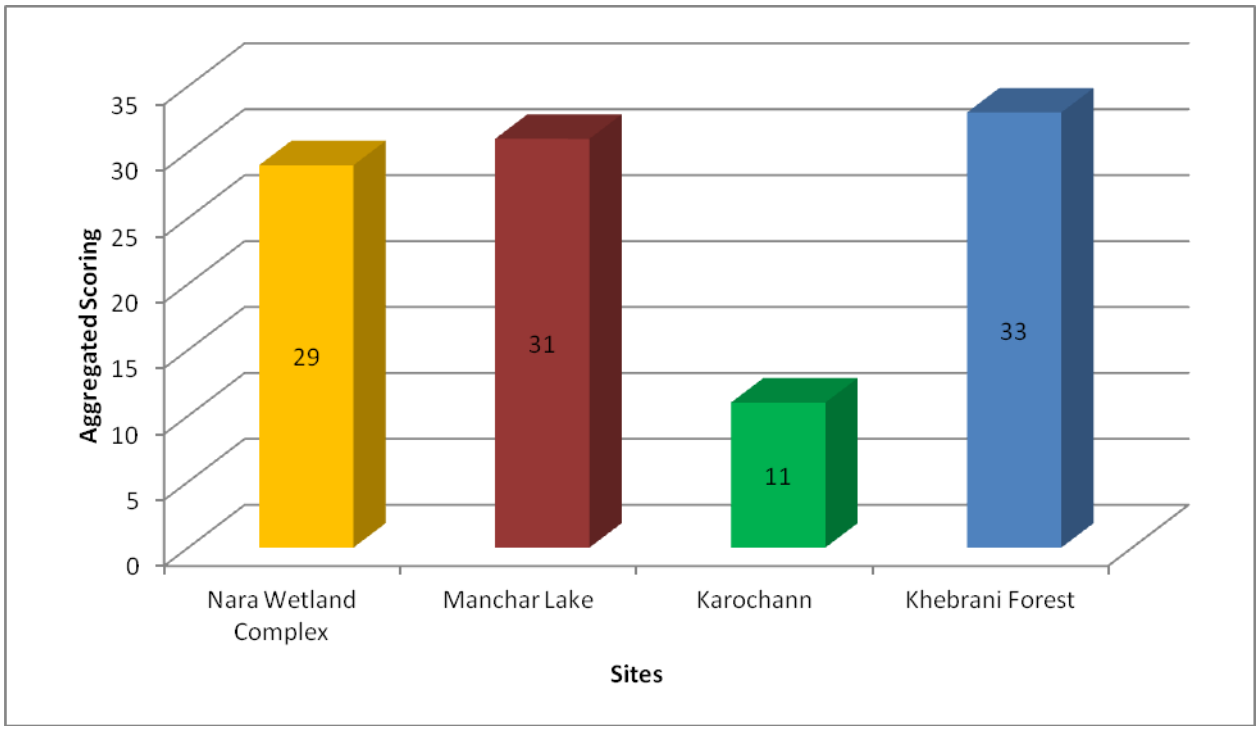
Khebrani Forest and Manchar Lake had the highest averaged disturbance factor against the species that were recorded there. Though this is an arbitrary scoring it does give an indication over the overall threat to large mammals at each site. Figure 22 gives the aggregated score for all sites.

Table 18 Threats Ranking for Large Mammals at Sites

S.No	Nature of Threats	Nara Wetland Complex	Manchar Lake	Kharochann	Khyberani Forest
1	Habitat removal/ degradation	3	4	1	4
2	Wood cutting	2	1	2	5
3	Hunting Pressure	5	4	1	5
4	Poaching/ Live trapping	3	3	1	3
5	Food Competition with livestock	2	2	-	2
6	Use of fie arms	4	4	-	5
7	Pollution	2	5	3	1
8	Weak enforcement of wildlife laws	5	5	2	5

9	Law and order situation	1	1	-	3
10	Natural threats	2	2	1	-
	Total Score	29	31	11	33
1 = low, 2 = medium, 3 = average, 4 = significant, 5 = high					

Figure 10 Aggregated score for distribution factors across sites



4.2 Small mammals

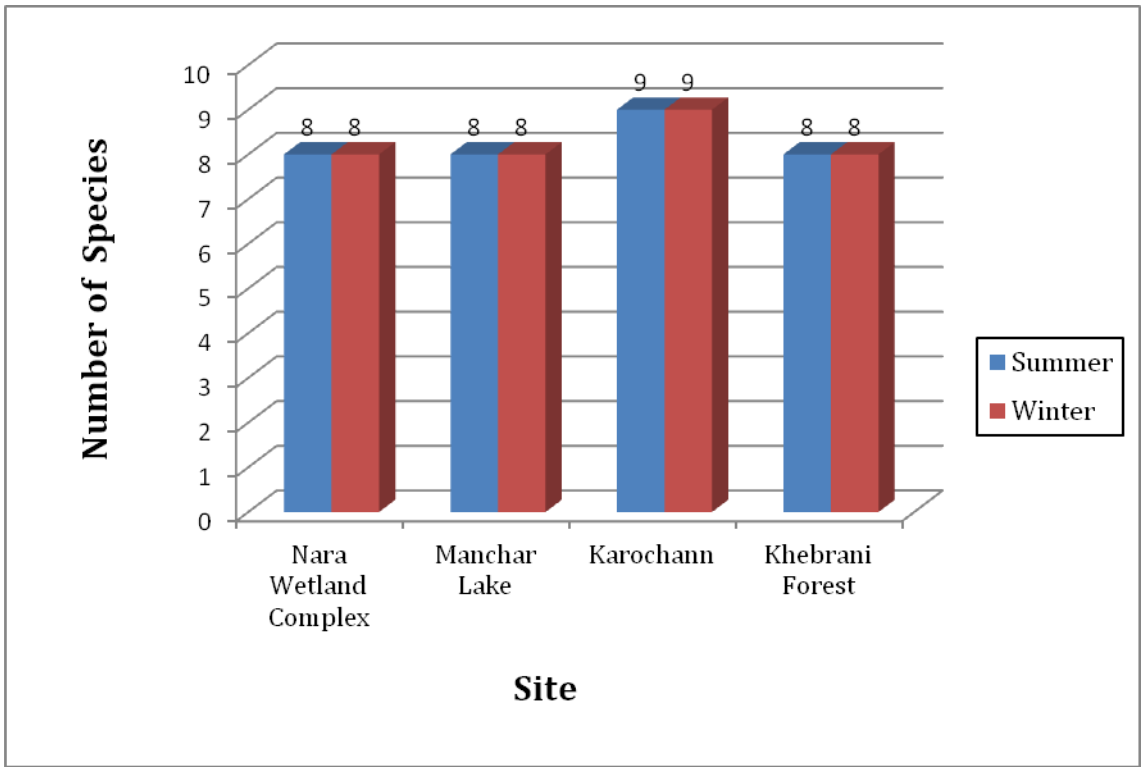
4.2.1 Species recorded

A total of 11 small mammal species were observed from the four sites, 8 from Nara Wetland Complex, 8 from Manchar Lake, 9 from Kharochann and 8 from Khebrani Forest. Most of small mammals are widespread and have been recorded from all of the four sites. The widespread small mammals were Palm Squirrel, Common House Mouse, Indian Gerbil, Indian Desert Gerbil, Indian crested Porcupine and Desert Hare. The species which is restricted to only one site were Mole rat Kharochann and Indian hedge hog at Khyberani Forest. Table below gives an account of species found at each side.

Table 19 LIST OF SMALL MAMMAL SPECIES RECORDED FROM EACH SITE

	Common Name	Nara Wetland Complex		Manchar Lake		Karochann		Khebrani Forest	
		W	S	W	S	W	S	W	S
1	Palm Squirrel	+	+	+	+	+	+	+	+
2	Common Rat					+	+	+	+
3	Common House Mouse	+	+	+	+	+	+	+	+
4	Indian Mole Rat					+	+		
5	Indian Gerbil	+	+	+	+	+	+	+	+
6	Indian Desert Jird	+	+	+	+	+	+	+	+
7	Balochistan Gerbil	+	+	+	+	+	+		
8	Indian crested Porcupine	+	+	+	+	+	+	+	+
9	Desert hare	+	+	+	+	+	+	+	+
10	Indian hedgehog							+	+
11	Long eared Hedge hog	+	+	+	+				

Figure 11 below shows the number of small mammal species recorded at each site over winter and summer.



4.2.2 Feeding habits

The feeding habits of small mammals varied over sites with no particular trend over sites. Figure 26 and 27 give details of the percentage of species in each site against the main feeding habits.

Figure 12 – Percentage of species recorded for each site over feeding habit

	Common Name	Karochann			Khebrani Forest			Manchar Lake			Nara Wetland		
		W	S	%	W	S	%	W	S	%	W	S	%
1	Grainivore	7	7	*77.7*	4	4	*57.1*	5	5	*62.5*	5	5	*62.5*
2	Herbivore	2	2	*22.2*	2	2	*28.5*	2	2	*25*	2	2	*25*
3	Insectivore	-	-	*0*	1	1	*14.3*	-	-	*0*	-	-	*0*
4	Omnivore	-	-	*0*	-	-	*0*	1	1	*12.5*	1	1	*12.5*

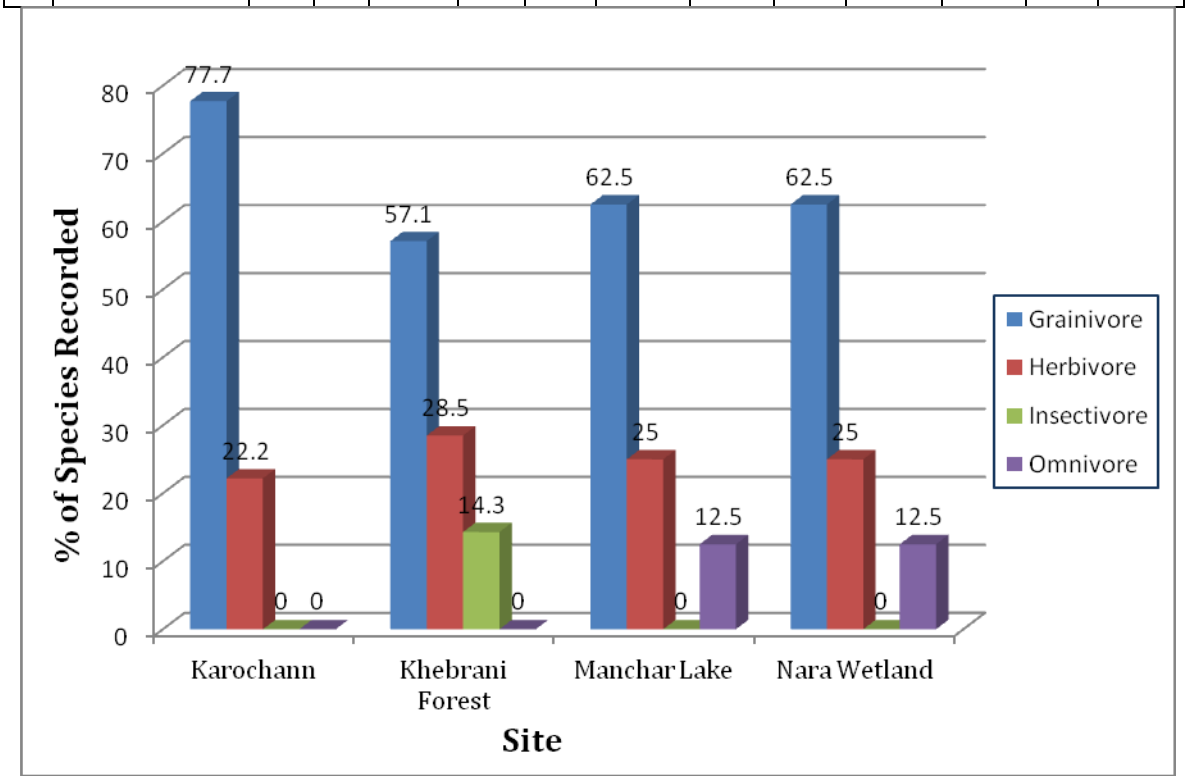
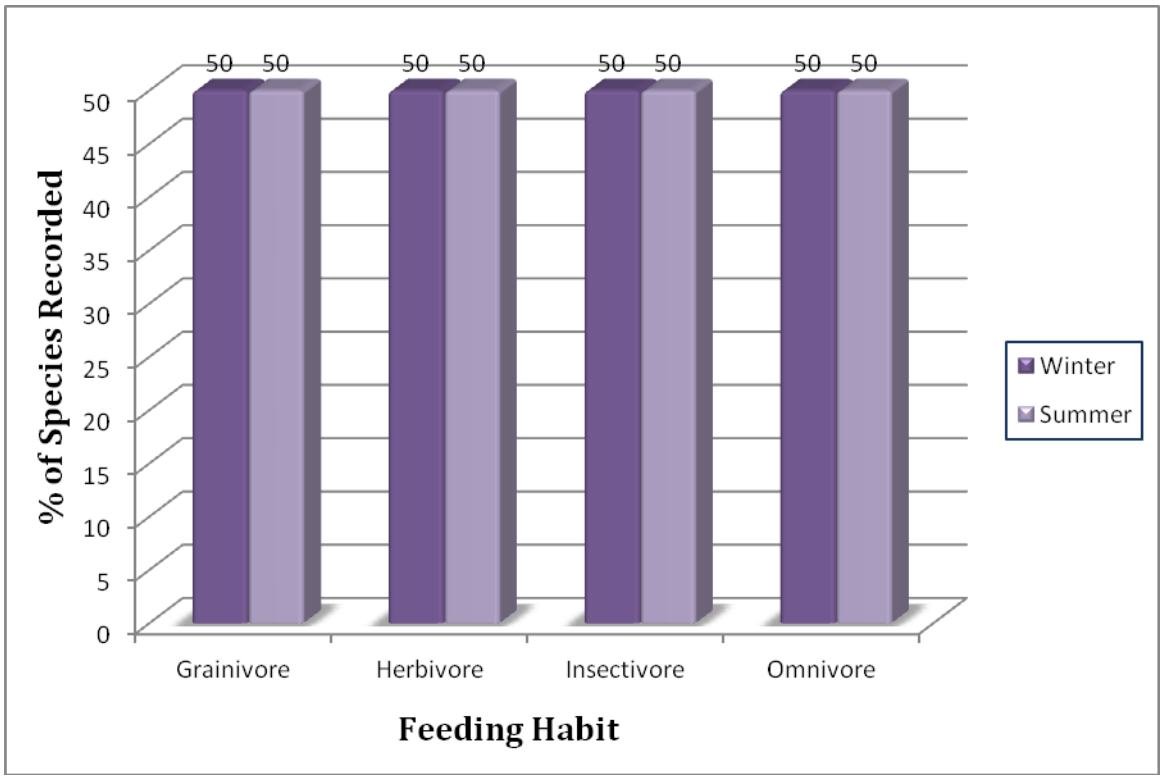


Figure 13 – Percentage of species recorded over season and against feeding habits



4.2.3 Habitat

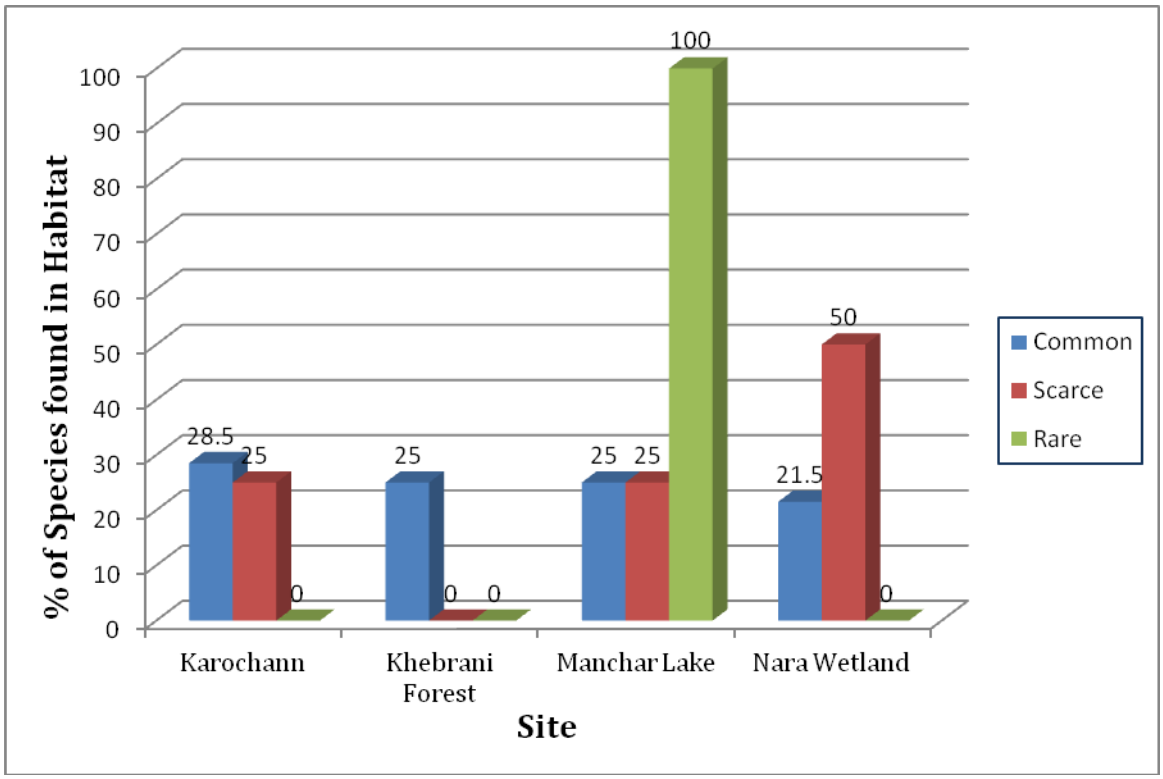
Over the four sites agriculture habitat supported the most species with more than 53% of all records being taken from agriculture habitats followed by sandy habitat (34.4%) and open land (12.5 %)

4.2.4 Status of small mammals across the survey sites

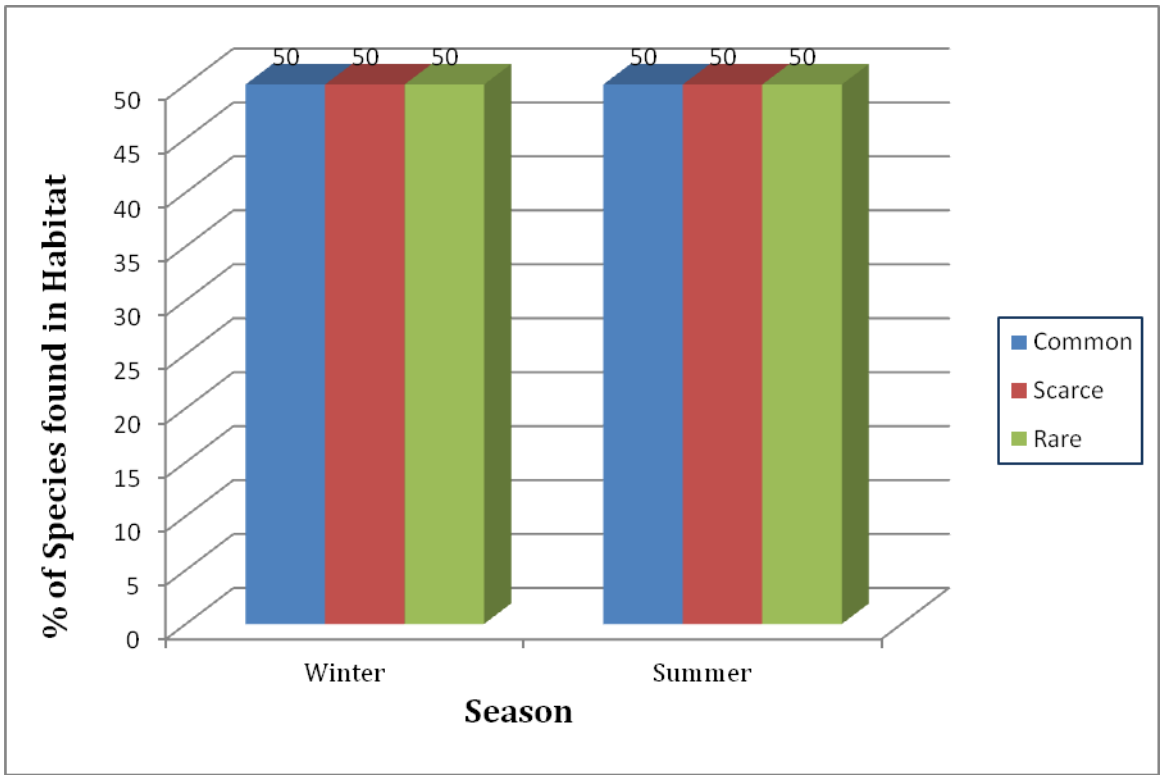
All the small mammals recorded during the survey were categorized as Common or of Least Concern. There are no rare, endangered or endemic species though many parts of the country are data deficient for several species so these categories are still quite speculative. There was no obvious trend or dominance of the two categories.
Figues 15 and 16 show the results over site and season

Figure 15 – Percentage of species recorded across sites against status categories

Figure 16 – Percentage of species recorded across sites



against season categories



4.3 Reptiles and amphibians

4.3.1Summary

During surveys, 38 species of reptiles and amphibians were observed. Among them, 27 species were recorded from Nara Wetland Complex, 20 from Manchar Lake, 14 from Kharochann and 11 from Khebrani forest. Even though this was a preliminary and brief survey there is a possibility thatmore species might be observed during a future detailed ecological survey.

The detailed biological assessment with regard to the reptiles and amphibians were made on four sites *viz.* Chotiari Reservoir, Kinjhar Lake, Pai Forest and Keti Bunder by the Indus for All Programme in 2007 - 2008. Then, during the study 27 species of amphibians and reptiles were recorded from Keti Bunder, 23 species from Kinjhar, 31 from Chotiari Reservoir and 18 species from Pai Forest.

Being excellent biological indicators, the amphibians and reptiles respond quickly to weather or climate changes and take refuge into burrows in case of danger and unfavourable conditions. The amphibians and reptiles are mostly nocturnal species and therefore survey during night is more appropriate for study of reptiles. However due to some constraints, night survey could not be undertaken at few sites. Amphibian and reptilian activity is also restricted to specific time of the day and specific season of the

year. When proper time and habitat for survey is not considered then there is possibility of sighting of species become minimal.

There is always a need of consistent monitoring of amphibian and reptilian species during their activity period, over the months for several years to comprehensively record the potential herpeto-fauna. This was indeed the limiting factor in such short duration surveys. All these factors indicate the practical difficulties in the documentation of these species. There is a great need to carry out more work in order to add to the existing lists. The future studies need more time to effectively prepare herpeto-faunal inventory of the area.

4.3.2 Species recorded

A total of 37 species of reptiles and amphibians were recorded from the four sites during present study. Among them, 27 species of Amphibians and reptiles were recorded from Nara Wetland Complex, 20 species from Manchar Lake, 14 species from Kharo chann and 11 species from Khebrani Forest. There was no difference in number of species in winter and summer surveys, except one additional species from Manchar was recorded in summer.

Indian Garden Lizard, Bengal Monitor, Indian Cobra, Saw scaled Viper and Skittering Frog were the only species recorded from all the four sites. Mugger Crocodile, Brown River Turtle, Spotted Pond Turtle, Glossy bellied Racer and Checkered Keelback were only recorded from Nara Wetland Complex. Similarly, Brilliant Agama, Yellow-headed Rock Agama, Red throat Agama, Punjab Snake-eyed Lacerta and Indus valley Wolf Snake were only recorded from Manchar Lake. Warty Rock Gecko and Bronze Grass Skink were only observed at Khebrani Forest. There were not any exclusive species in Kharochann.

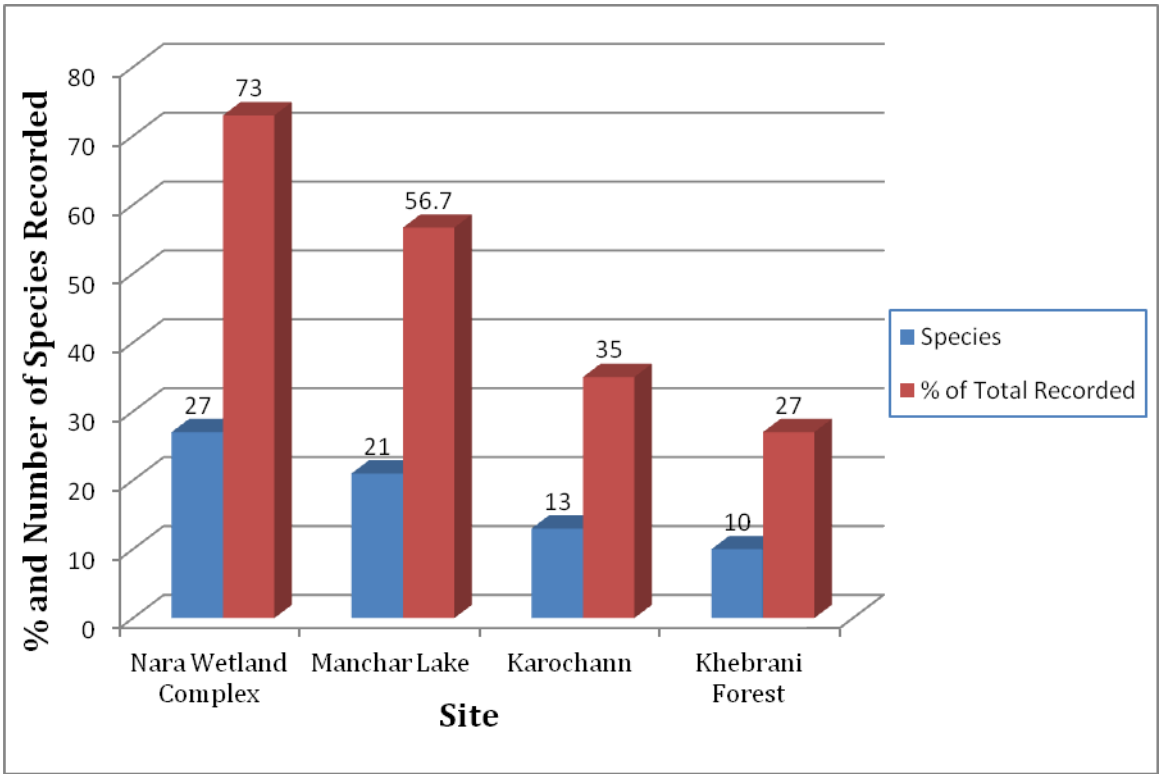
The list of species recorded from each site is given in the following Table.

Table 20 - LIST OF REPTILES AND AMPHIBIA SPECIES RECORDED FROM EACH SITE

	Common Name	**Nara Wetland Complex**		**Manchar Lake**		**Karochann**		**Khebrani Forest**	
		W	**S**	**W**	**S**	**W**	**S**	**W**	**S**
1	Mugger Crocodile	+	+						
2	Saw-back Turtle	+	+			+	+		
3	Brown River Turtle	+	+						
4	Spotted Pond Turtle	+	+						
5	Indian Soft-shell Turtle	+	+						
6	Indian Flap-shell Turtle	+	+	+	+			+	+

7	Tree or Indian Garden Lizard	+	+	+	+	+	+	+	+
8	Afghan Ground Agama	+	+	+	+	+	+		
9	Brilliant Agama			+	+				
10	Yellow-headed Rock Agama			+	+				
11	Red throat Ground Agama				+				
12	Yellow-bellied House Gecko	+	+	+	+	+	+		
13	Spotted Indian House Gecko	+	+	+	+				
14	Keeled Rock Gecko	+	+	+	+				
15	Warty Rock Gecko							+	+
16	Three fingered Sand fish	+	+	+	+				
17	Indian Sand Swimmer	+	+						
18	Bengal Monitor	+	+	+	+	+	+	+	+
19	Indo-Pak Desert Monitor	+	+	+	+				
20	Bronze Grass Skink	+	+					+	+
21	Indian fringe-toed Sandy Lizard	+	+	+	+				
22	Punjab Snake-eyed Lacerta			+	+				
23	Indian Cobra	+	+	+	+	+	+	+	+
24	Saw scaled Viper	+	+	+	+	+	+	+	+
25	Indian or Common Krait					+	+		
26	Indian Sand boa	+	+	+	+				
27	Afro-Asian Sand Snake					+	+		
28	Rope Snake or Dhaman					+	+		
29	Indus valley Wolf Snake			+	+				
30	Sind Awl-headed Sand Snake	+	+						
31	Cliff Racer	+	+	+	+				
32	Glossy bellied Racer	+	+						
33	Checkered Keelback	+	+						
34	Marbled Toad	+	+	+	+			+	+
35	Bull frog	+	+			+	+	+	+
36	Skittering Frog	+	+	+	+	+	+	+	+
37	Indus valley Toad					+	+		

Figure 17 – Percentage of species and total species number recorded from each site



4.3.3 Species diversity

The following tables and figures examine the diversity of each site plus the evenness across the sites. This analysis incorporates both winter and summer season data.

The results in Table 21 show that Manchar Lake has the highest species account, followed by Nara Wetland Complex, Kharochann and Khebrani Forest. However the evenness analysis shows that Kharochann has more evenness ratio followed by Nara Wetland Complex, Manchar Lake and Khyberani Forest.

Table 21 Species Diversity

S. No.	Type of index	Nara Wetland Complex	Manchar Lake	Kharo chann	Khebrani Forest
1	Richness (number of species)	27	20	14	11
2	Evenness	1.29	0.92	1.41	0.75
3	Shannon Index	2.49	2.75	3.71	1.81
4	Mergalef Index	2.95	2.91	2.86	2.32

4.4 Avi-fauna

4.4.1 Summary

4.4.1.1 Nara Wetland Complex

The Nara Wetland Complex comprises of Nara Canal and a complex of about 225 small, medium and large wetlands or *dhands* on either side of the canal. These wetlands are either permanent or seasonal and are fresh water to brackish or saline. The majority of wetlands has an area of about 200 ha and is surrounded by sand dunes. Many dry out completely during winter and early spring. The area provides diverse habitat for a wide variety of birds which include lakes, marshes, desert, agriculture areas, fish ponds, wasteland and villages.

The wetlands of the Nara complex are the important wintering and staging ground of the migratory water birds that hosts a variety of rare and endangered bird fauna.

A total of 118 species of birds belonging to 13 orders and 37 families were recorded. Out of 118 species recorded, 53 are winter migrants, 59 resident, 4 passage migrants and two year round visitor birds. These include the vulnerable species, Marbled Teal *(Anas angustirostris)* and Near Threatened species of Ferruginous Duck *(Aythya nyroca)*, and Indian Darter *(Anhinga rufa)*. The trend of presence of rare and endangered species recognizes the ecological importance of the area.

Ghalib *et al.* (2008) recorded 78 species of birds from the wetlands of the adjoining Nara Desert Wildlife Sanctuary. These also included the threatened species *viz.* Indian white beaked vulture and Houbara Bustard. They also recorded breeding of red wattled lapwing, white tailed plover, black winged stilt and black headed myna from the area.

Bailley (2005) recorded the occurrence of large pied wagtail *(Motacilla maderaspatensis)* and rock bunting *(Emberiza cia)* from Nara area which is for the first time from Sindh province.

4.4.1.2 Manchhar Lake

It is the largest freshwater perennial lake formed in the natural depression. The lake is located in Dadu district of Sindh province. The lake is fed by two canals, the Aral Wah and the Danister from the river Indus. The lake also collects water from numerous small streams in the Kirthar mountain.

There has been continuous environmental degradation of this wetland and water of the lake is becoming saline. The diversion of water from the Indus and run off from Kirthar mountains have contributed to the reduction in fresh water supplies. At the same time,

saline drainage water from agricultural fields in the surrounding areas also flows in to the lake. Pollution through the Main Nara Valley Drain (MNVD) is the main threat to the lake. It brings agricultural, municipal, industrial and saline water which is the constant polluting sources of the lake. The lake is also facing eutrophication.

Manchhar Lake has multiple habitats, North East is plain and predominant agronomical and South west consists of hilly and range land. The lake has been an important wintering and staging ground of migratory birds and home to resident birds. As many as 45,000 birds were counted in winter of 1991 and 32,000 birds in 2000 at this lake. But due to lake degradation the population is declining gradually.

4.4.1.3 Kharochann

Kharochann is a coastal area situated at a distance of about 220 km SE of Karachi in Thatta district. The area mostly consists of mangroves, marshes, fallow land, agricultural land, built up area, water channels, river bank, coastal area and the creek area. There are six major creeks in the area viz. Chann, Rohra, Ghora, Khichry, Mal and Wari creek.

The area is facing environmental degradation, particularly facing acute scarcity of fresh water and sea water intrusion. The intrusion is causing high salinity of the soil.

The area has great ecological significance and is the wintering ground of many species of waterbirds. Karochann is an important area for a variety of bird species. The area has significant biodiversity value, especially the wintering activities of avifauna. The migratory birds particularly the shorebirds, egrets and herons, gulls and terns, pelicans and flamingos that stopover for feeding, resting and roosting purpose. As many as 85 species of birds have been recorded from the area.

4.4.1.4 Khyberani Forest

Khyberani Forest is in Matiari District. It was a riverine forest which depended on Indus river water prior to the construction of Sukkur Barrage. It has been declared as a reserve forest by the Sindh Forest Department. The forest consists of 25 compartments and the total area of forest is about 3,000 acres.

A total of 61 species of birds belonging to 11 Orders and 30 Families were recorded. The Grey and Black Partridges are the key species of the area. Among the total recorded species 43 were resident and 18 migrants. Some less known species were recorded from the area such as Oriental Honey Buzzard, Northern Goshawk, Eurasian Sparrow Hawk and Long billed Pipit. Lot of open area is being converted into agriculture fields and thus habitat degradation is continued.

4.4.2 Species recorded

The total number of bird species recorded on each site is shown below.

Table 22 – Total number of bird species recorded at each site

S. No.	Total No. of Species recorded on each site	No. of Species
1.	Nara Wetland Complex	118
2.	Manchhar Lake	75
3.	Kharochann	85
4.	Khyberani Forest	61

The total number of birds species recorded from all the 4 sites is 149 species. A total of 80 species of birds were recorded in summer and 146 species in winter. The total numbers of birds recorded in winter was 15,248 and in summer 6,824.

Table 23: LIST OF BIRD SPECIES RECORDED FROM EACH SITE

	Common Name	Nara Wetland Complex		Manchar Lake		Karochann		Khaiberani Forest	
		W	S	W	S	W	S	W	S
1	Black necked Grebe	+							
2	Little Grebe	+		+	+				
3	White Pelican			+					
4	Large Cormorant	+	+	+					
5	Little Cormorant	+	+	+	+	+	+		
6	Indian Darter	+							
7	Grey Heron	+				+	+		
8	Purple Heron	+							
9	Indian Pond Heron	+	+	+	+	+	+	+	+
10	Cattle Egret	+	+	+	+	+	+	+	+
11	Large Egret	+		+		+			
12	Intermediate Egret	+	+	+		+		+	
13	Little Egret	+	+	+	+	+	+	+	+
14	Reef Heron	+	+	+	+	+	+		
15	Painted Stork					+			
16	Spoonbill			+					
17	Yellow Bittern	+							
18	Black Bittern		+				+		
19	Little Bittern	+	+						

20	Spoonbill			+					
21	Ruddy Shelduck	+							
22	Common Shelduck			+					
23	Marbled Teal		+						
24	Common Teal	+		+					
25	Mallard	+							
26	Gadwall	+							
27	Shoveller	+		+					
28	Common Pochard	+							
29	Ferruginous Duck	+							
30	Tufted Duck	+							
31	Common Kite	+	+	+	+	+	+	+	+
32	Blackwinged Kite	+		+	+	+			
33	Brahminy Kite	+		+		+	+		
34	Oriental Honey Buzzard							+	
35	Northern Goshawk							+	
36	Shikra	+		+	+	+	+	+	+
37	Eastern Sparrow Hawk							+	
38	Long legged Buzzard			+				+	
39	White eyed Buzzard	+					+		
40	Marsh Harrier	+	+	+		+			
41	Osprey	+				+			
42	Merlin							+	
43	Common Kestrel	+		+				+	
44	Grey Partridge	+	+	+	+	+	+	+	+
45	Black Partridge	+	+			+		+	
46	White breasted waterhen	+				+	+		
47	Indian Moorhen	+	+	+	+				
48	Purple Moorhen	+	+						
49	Common Coot	+		+					
50	Oystercatcher					+			
51	White tailed Plover	+		+					
52	Redwattled Lapwing	+	+	+	+	+	+		+
53	Yellow wattled Lapwing			+	+				
54	Little Ringed Plover	+		+		+	+		
55	Kentish Plover	+		+		+	+		
56	Lesser Sand Plover	+				+			
57	Greater Sand Plover	+							
58	Whimbrel	+				+			
59	Curlew	+		+		+			
60	Bartailed Godwit	+				+	+		
61	Common Redshank	+		+		+			
62	Marsh Sandpiper	+				+			
63	Greenshank	+				+			
64	Wood Sandpiper	+							

65	Common Sandpiper	+		+		+			
66	Common Snipe	+							
67	Little Stint	+		+		+			
68	Dunlin	+	+						
69	Ruff	+		+					
70	Black winged Stilt	+	+	+	+	+	+	+	+
71	Crab Plover	+				+			
72	Heuglin's Gull	+		+	+	+			
73	Brown headed Gull	+		+		+			
74	Black headed Gull	+	+	+		+	+		
75	Slenderbilled Gull	+	+	+		+	+		
76	Caspian Tern	+		+	+	+	+		
77	Gull billed Tern	+							
78	River Tern	+	+	+	+	+	+	+	+
79	Black bellied Tern	+				+			
80	Little Tern	+	+	+	+	+	+		
81	Sandwich Tern	+				+			
82	White cheeked Tern						+		
83	Chestnut bellied Sandgrouse			+	+				
84	Blue Rock Pigeon	+	+	+	+	+	+	+	+
85	Ring Dove	+	+	+	+	+	+	+	+
86	Little brown Dove	+	+	+	+	+	+	+	+
87	Crow Pheasant	+	+			+	+	+	+
88	Common Koel		+				+		
89	Rose ringed Parakeet		+				+		
90	Lesser Golden Woodpecker								+
91	Sykes's Night jar	+							+
92	Barn Owl	+							
93	Spotted Owlet	+	+						+
94	Pied Kingfisher	+	+	+	+	+	+		
95	Common Kingfisher	+	+	+		+		+	
96	White breasted Kingfisher	+	+	+	+	+	+	+	+
97	Green Bee eater	+	+	+	+	+	+	+	+
98	Blue-cheeked Bee eater		+						
99	Indian Roller	+	+	+	+	+		+	+
100	Common Hoopoe	+	+	+	+			+	
101	Desert Lark	+	+	+		+			
102	Greater Short toed Lark	+	+			+			
103	Crested Lark	+	+	+	+	+	+	+	+
104	Pale Martin	+		+		+		+	
105	Crag Martin	+	+			+			
106	Common Swallow	+		+		+		+	

107	Wire tailed Swallow		+				+		
108	Rufous tailed Shrike	+		+		+		+	
109	Southern Grey Shrike	+	+	+		+			
110	Bay backed Shrike	+							
111	Striated Shrike		+						
112	Black Drongo	+	+	+	+	+	+	+	+
113	Rosy Pastor			+	+				
114	Bank Myna			+	+		+	+	+
115	Indian Myna	+	+	+	+	+	+	+	+
116	Common Starling	+		+	+				
117	Tree Pie	+						+	+
118	House Crow	+	+	+	+	+	+	+	+
119	White Cheeked Bulbul	+	+	+	+	+	+	+	+
120	Red vented Bulbul	+	+					+	+
121	Common Babbler	+	+	+	+	+	+	+	+
122	Jungle Babbler	+	+					+	+
123	Striated Babbler	+							
124	White-browed Fantail Flycatcher	+				+		+	
125	Common Chiffchaff	+				+			
126	Clamarous Reed Warbler	+						+	
127	Yellow bellied Prinia	+	+					+	
128	Rufous vented Prinia	+	+	+				+	
129	Tailor Bird							+	+
130	Lesser Whitethroat	+						+	
131	Common Chiffchaff	+		+				+	
132	Greenish Warbler	+							
133	Bluethroat							+	
134	Black Redstart	+		+				+	
135	Pied Bushchat	+	+	+	+	+	+	+	+
136	Isabelline Wheatear	+				+		+	
137	Desert Wheatear	+		+		+			
138	Hume’s Wheatear	+	+	+	+	+			
139	Indian Robin	+	+			+		+	+
140	Paddyfield Pipit							+	+
141	Longbilled Pipit							+	
142	White wagtail	+	+	+		+		+	
143	Yellow wagtail	+		+		+			
144	White browed Wagtail		+						
145	Purple Sunbird	+	+			+	+	+	+
146	House Sparrow	+	+	+	+	+	+	+	+
147	Jungle Sparrow	+	+			+		+	+
148	Streaked Weaver Bird		+						
149	House Bunting			+	+				

4.5 Physico-chemical properties of water

4.5.1 Summary of water quality

4.5.1.1 Drinking water

- **Manchhar Lake**

  Samples were collected from three sites in Manchhar area. The sample of lake water was collected from Goth Bubak, Zero Point at Goth Muhammad Mallah and from Outlet at Shawan. Samples were also collected for Microbiological analysiss from the three sites.

  The total dissolved solid, TDS (or conductivity) is important along with pH in determining the water quality. The pH varies from 7.76 – 7.92 in samples which is acceptable range. The conductivity ranges from 2908µS – 4070µS. However, the turbidity (TSS) is higher on two sites i.e. 14 NTU and 33 NTU but within the WHO standard at Goth Bubak.

  The hardness of water ranges from 733.6 mg/l and 931 mg/l and above the prescribed standard of National Standards (WHO) which is less than 500 mg/l. The concentration of As was found to be high in water samples collected from Outlet Shawan which is higher than the permissible limit of WHO.

  The microbiological analysis of samples was also done which indicated the presence of Fecal coliform from 64 cfu/100 ml – 148 cfu/100 ml while the recommended value as per WHO/SEPA for Drinking water is 0 cfu/100 ml. The presence of Fecal coliform in freshwater is an indicator of contamination with human and animal excreta.

  The overall study shows that water quality of Manchhar lake is degraded. The water is polluted, especially due to waste water of agriculture and domestic wastes of surrounding areas coming through MNVD. The fishing and boating activities are also among the sources responsible for lake water quality deterioration.

- **Kharochann**

  Sampling was made during February 2011 from selected location at Kharochann. The main source of fresh water in Kharochann is hand pumps and well. Unfortunately these have been destroyed by the floods and cyclones in 1999 and 2010. This led to the scarcity of drinking water in the area and many people living in taluka which has about 200 islands also migrated from the area.

  The Chloride level in the sampled water has been higher as compared to the National Standard for Drinking Water Quality. Chloride in drinking water may have come from the saline intrusion. The turbidity is also very high *i.e.* 81 NTU as compared to the prescribed standard of 5 NTU. The water has hardness concentration of 1000.4 mg/l which means is higher than the standard limit.

The microbiological analysis of the sample shows the presence of Faecal coliform which is harmful for human health. The presence of these bacteria in water may cause water borne diseases like dysentery, gastroenteritis, typhoid fever and hepatitis A. The presence of the bacteria in water indicates a higher risk of pathogens being present in water. The water is microbiologically unsatisfactory for human consumption.

- **Nara Wetland Complex**
  The water quality in area is generally sweet. Total dissolved solids (TDS) lies between 500 to 800 ppm. There are also brackish lakes and TDS varies from 10,000 to 28,000 due to less recharge. The ground water quality is dominated by Sulfate, Cl and Ca Mg ions (Halcrow 2002). The TDS (or conductivity) is important parameter along with pH in determining the water quality. The value of both is acceptable in freshwater lakes while it is otherwise in saline lakes.

  The turbidity is higher and above the WHO standard of 5 NTU. The higher turbidity may be due to the waste discharge and/or agriculture run off.

  Nara canal originates from River Indus. The Indus water is generally contaminated carrying organic and inorganic pollution load from upstream human activities. The Sindh Environmental Protection Agency (SEPA 2002) reported that the Indus River BOD is over 6.5 mg/l, which according to Global Environmental Monitoring System (GEMS) classification puts this river as highly polluted.

  The microbiological analysis of water of the two sites confirmed the presence of Faecal coliform. The water containing Faecal coliform is harmful for human consumption as this may cause water borne disease. The presence of Faecal coliform in fresh water bodies is an indicator of contamination with human and animal excreta.

4.5.1.2 Agriculture

- **Manchhar Lake**
  The water of Manchar lake was predominantly used for agriculture. The degradation of the lake including increase in salinity has affected the crops. The salinity of water is related to conductivity. The salty water has greater conductivity. The water was not analysed as per guidelines for agriculture purpose.

- **Kharochann**
  The water analysis of water was done as per national standards for drinking water quality and analysis does not reflect the acceptable standard for agriculture. The TDS was not measured.

- **Nara Wetland Complex**

4.5.1.3 Fisheries

Water quality parameters were only taken to determine the quality of water for drinking purpose. However, it has been noted that the population of 100,000 fishermen who were directly linked with fishing occupation have suffered in recent years. Increased inflow of saline effluent has resulted in the devastation of the lake.

Table – Water quality parameters over site

Parameters	Manchhar Lake	Kharochann	Nara Wetland Complex
pH	7.76 – 7.92	7.70	8.06 – 8.58
Chloride	733.6 mg/l – 931.5 mg/l	2678 mg/l	26.2 mg/l – 153.7 mg/l
Conductivity	2908 µS – 4070 µS	9310 µS	316 µS – 1652 µS
Turbidity	14 NTU – 33 NTU	81 NTU	10 NTU – 16 NTU
Total Hardness	733.6 mg/l – 931mg/l	1000.4 mg/l	153.9 mg/l – 378.3 mg/l
Total Alkanity	136.3 mg/l – 160 mg/l	106.7 mg/l	118.3 mg/l – 525 mg/l
Cr (Hexa)	0.01 mg/l – 0.05 mg/l	0.01 mg/l	0.02 mg/l
Lead	BDL	BDL	BDL
Zn	BDL	BDL	BDL
COD	58 mg/l – 106 mg/l	18	BDL
Iron	BDL	BDL	BDL
As	0.025 mg/l – 0.1mg/l	BDL	BDL

BDL = Below detection limit

Table – Microbiological Parameters over site

Parameter	Manchhar Lake	Kharochann	Nara Wetland Complex
Faecal coliform	64 cfu/100 ml – 148 cfu/100 ml	64 cfu/100 ml	83 cfu/100 ml – 250 cfu/100 ml

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