ECOLOGICAL ASSESSMENT OF FAUNA

at Kharochann, District Thatta, 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	**International Union for the Conservation of Nature**
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. 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 (IFAP)* at the first instance was implemented on four out of fifteen prioritized landscapes.

The second phase of implementation of *Indus for All Programme* will start 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.

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

The total population of Kharochann and adjacent creeks is estimated at 50,000. Majority of them are fishermen and belong to Dabla, Baloch, Jat, Memon, Sheikh, Solangi, Khaskhely, Syed, Murgar and other tribes. The people are living below the poverty line and therefore, their dependence on local natural resources is enormous.

Kharochann has been encroached by sea water. Traditionally, water of River Indus used to flow through here and then flowing into the sea throughout the year. Now, the sea water has intruded and ruined the fertile lands. The local lands are continuously being engulfed by fast spreading sea water and the Indus Delta is destroyed. According to local people, at the time of creation of Pakistan, Kharochann was a part of mainland and now it is an island. The fresh water and brackish water ecosystem have changed to marine.

There are three major sources of livelihood for the communities of the area i.e. agriculture, livestock and fishing. Kharochann had good agrarian economy in the past and produced plenty of high quality rice. The agriculture has now deteriorated due to water logging and salinity of lands. Now fishing is the major profession of local people. *Palla*, the key fish species used to be common and the major catch when the influx from the Indus was frequent here.

The local fishermen used to catch famous prized Palla fish (*Tenualosa ilisha*) in large quantity till about two decades ago. This fish has migratory habits and for breeding ascends upstream in the river Indus from the Arabian Sea (Jafri and Melvin, 1988). The fish has been reported to ascend as far as Multan before the construction of barrages on

the river Indus but presently it is reported to travel up to Kotri Barrage for breeding, from July to September (Narejo *et al.,* 1998). Subsequently, the fish fries and the adult return to Arabian Sea and this activity pattern continues year after year. Due to very low discharge of Indus and lack of flooding the fish has been unable to migrate upstream for breeding and hence the stocks of Palla fish have been depleted at an alarming pace during the last 15 years.

According to locals, the population of prawn has also been decreasing over the recent years and thus reducing their income. This is mainly due to impact of use of illegal nets like Boola and Gujja which indiscriminately trap all types of fishery resources including the small and medium sized fish, prawn and crab.

Life is miserable in the area and even drinking water is not available for locals. Both underground and surface freshwater resources have been degraded by sea intrusion. The villagers consume about 1000 gallons of water daily which they buy @ Rs.10 per gallon. The area has no basic civic and health facilities. There is a health centre but without required facility. There is single primary school for 25 villages of the area.

Eight species of mangroves have been reported to occur in the area but six species have been lost from Indus Delta including Kharochann during the past 70 years but now two species have been re-introduced in the delta. The locals use mangroves for fodder and fuel wood, camel browsing and hut making. The mangroves found in Kharochann and surrounding areas is facing severe pressure due to multiple social and ecological reasons and this is leading to a tremendous and rapid decline in the biodiversity involving many faunal species of crabs, shrimps and other economically important invertebrates. The decline in mangrove cover over the last two decades is an alarm to the ecologically fragile ecosystem, which may ultimately result in decline in invaluable invertebrate species depending on this ecosystem. This would disturb the food chain as well causing disappearance of many species from the area.

The entire coastal area of Sindh is included in the warm monsoon climatic region. Hoekstra *et al.* (1997) reported that climatically Indus Delta can be designated as subtropical maritime desert. There are two distinct seasons; summer (March – June) and winter (November to February). Average annual rainfall is about 221 mm and in some years virtually there is no rainfall during the monsoon season. Winds blow from the west from March to October and from north-east from November to January. During peak monsoon season, wind speed rises to an average of 8 knots. There has also been a drought in the area from 1999 to 2005.

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. In monsoon, the area is rich by the great treasure of traditional Palla fish *(Tenualosa ilisha)*, migrating from sea towards Indus river.

This is the first detailed study of its kind on the fauna of the area. The fauna of the area has not been studied in detail earlier. This Ecological Assessment Study provides status of various ecological aspects of Kharochann, based on field surveys conducted in December 2010.

Large Mammals: The area has very limited distribution of large mammal species. Ten species of large mammals have been recorded. Only six species *i.e.* Jackal, Jungle Cat, Grey Mongoose, Small Indian Mongoose, Indian pangolin and Wild boar were observed. Fishing Cat, Desert Cat, Bengal fox and Small Indian Civet have also been reported from the area. There has been large scale habitat loss due to recent floods. The population of jackal has increased due to expanse in agricultural land and food availability.

Small Mammals: The habitat of small mammals was largely affected by the floods. Only 9 species of small mammals belonging to 2 orders and 4 families were recorded. According to feeding habits, 7 species were granivores and 2 herbivores.

The small mammals are not abundant in the areas affected by the advancing seas. Area of about 5 km along the coast does not have a rich diversity of small mammals. The area beyond this limit is used for agriculture, banana orchards, waste land with shrubby outgrowth and human settlements. These areas have population of small mammals and the most dominant species are *Tatera indica, Rattus rattus,* mongooses and house mouse. The species *Rattus rattus* and *Tatera indica* are serious crop pests and they are really abundant in these areas.

Birds: The main bird habitats are coastal area, mangrove forest, marshes and creeks, agricultural fields, fruit farms and small forest having *Mesquite, Salvadora, Capparis, Typha and Phragmites species*. A total of 85 species of birds belonging to 11 orders and 32 families were recorded. Among the total species recorded, 31 were migrants and 54 resident birds. There were altogether 36 species of waterbirds, 7 species of raptors, 29 species of passerines along with Pigeons, Doves, Kingfishers, Bee eaters, Roller and Partridges. The creek area, river channels and the marshes are the important habitats of the birds. Water birds and birds of prey are the dominant species during the migratory season. Oystercatcher, Crab Plover, Black-bellied Tern and Brahminy Kite are key species of the area.

Reptiles and Amphibians: During the survey, 11 species of reptiles belonging to 3 orders and 8 families were recorded. The important species included the Indian Saw-back Turtle and the Indian Monitor. The Indian Monitor has a decreasing population trend globally and status being 'Least Concern' (IUCN Red list 2011). This area has good population of snakes as they get plenty of food in the form of rodents. Tracks of non – poisonous snakes, lizards (Geckos) and (Agamas) commonly found in the area. The marine snakes are also commonly seen in sea water and often get trapped in fishing nets.

Three Amphibian species have also been recorded from the area comprising of Skittering Frog, Bull Frog and Marbled Toad.

Effectively, efforts need to be undertaken in order to capitalize the currently available resources and these are conserved in terms of quantity for the future generation.

Chapter 1: INTRODUCTION

1.1.1 Introduction to Kharochann

Kharochann is 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.

It is located in Indus delta experiencing warm monsoon climatic regime. Mid winters extend from November to February while summer season extends from March to October. Most of annual precipitation falls during monsoon, which is erratic in distribution. Mean annual rainfall is 200 mm. January is the coolest month with minimum temperature of 9.5ºC while in June – July minimum and maximum temperature ranges from 23ºC - 26ºC and from 30ºC - 36ºC respectively. Humidity is generally higher in the morning than in afternoon. It also varies from place to place depending upon the proximity to the sea. Wind is also important feature of coastal zone. It is variable and is faster during summer (7.4 to 20.5 km/hr) than in winter.

The total population of Kharochann and adjacent creeks is estimated at 50,000. Majority of them are fishermen and belong to Dabla, Baloch, Jat, Memon, Sheikh, Solangi, Khaskhely, Syed, Murgar and other tribes. The people are living below the poverty line and therefore, their dependence on local natural resources is enormous.

There are three major sources of livelihood for the communities of the area i.e. agriculture, livestock and fishing. Kharochann had good agrarian economy in the past and produced plenty of high quality rice. The agriculture has now deteriorated due to water logging and salinity of lands. Now fishing is the major profession of local people. *Palla*, the key fish species used to be common and the major catch when the influx from the Indus was frequent here.

Eight species of mangroves have been reported to occur in the area but six species have been lost from Indus Delta including Kharochann during the past 70 years but now two species have been re-introduced in the delta. The locals use mangroves for fodder and fuel wood, camel browsing and hut making. However, the camels now also graze on grasses growing on mudflats. The mangroves have been declared as a ‘protected Forest’ by the Sindh Forest Department.

The mangroves found in Kharochann and surrounding areas is facing severe pressure due to multiple social and ecological reasons and this is leading to a tremendous and rapid decline in the biodiversity involving many faunal species of crabs, shrimps and other

economically important invertebrates. The decline in mangrove cover may ultimately result in decline in shrimp production as it is the nursery of many species of fishes and shrimps. The invertebrate species depending on this ecosystem will also decline which would disturb the food chain of many vertebrate species.

Kharochann has been encroached by sea water. Traditionally, water of River Indus used to flow through here and then flowing into the sea throughout the year. Now, the sea water has intruded and ruined the fertile lands of the area. The local lands are continuously being engulfed by fast spreading sea water and the Indus Delta is destroyed.

1.1.1 State of biodiversity

The area has important habitat of mangroves, mudflats, coasts etc. and provide habitat to species of mammals, birds, reptiles and amphibians.

- **Mammals:** Fishing Cat, Jungle Cat, Desert Cat, Small Indian Civet, Bengal Fox, Jackal, Wild Boar, Mongoose, Desert hare and Squirrel are reported in the area. There is possibility of occurrence of marine dolphins in the coastal water as bottle nosed dolphin, hump backed dolphin and finless porpoise have been recorded from nearby Keti Bunder area during 2008 (IFAP Report 2008). It requires further investigation for confirming its presence in the area.

  In small mammals, 9 species belonging to two orders and 4 families were recorded.
- **Birds**: Kharochann is an important area for a variety of bird species. Many water birds, mainly larids and charadriids use the area during winter as staging, feeding and wintering ground. As many as 85 species of birds have been recorded from the area.
- **Reptiles:** Kharochann has a diverse habitat for reptiles and amphibians. There is possibility of occurrence of Marine Turtles on the sandy beaches but no evidence was found during the present survey. During the present survey, 11 species of reptiles belonging to three orders and 10 families were recorded which include five snakes, five lizards, one fresh water turtle.
- **Amphibia:** Three species of amphibians were recorded which included two species of frogs and one toad.

1.1.2 Livelihood and Social aspects

- **Social fabric:** Traditionally agriculture, livestock and fishing were the major sources of livelihood of the community of Kharochann. Due to reduction in fresh water supplies and sea water intrusion into the land, the agriculture of inland area is on decline causing high pressure on fishing, grazing and exploitation of mangroves for fuel and timber. Presently, about 90% of local people are engaged

in fishing followed by agriculture, livestock rearing and jobs/services in various sectors.

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* in the first instance was implemented on four out of fifteen prioritized landscapes viz. Keti Bunder (coastal), Keenjhar 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 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.

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 above mentioned sites. The baseline will determine key livelihood 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 - sustaining 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 stems 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 herbivory 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.

1.2.1.2 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.

1.2.2 Reptiles and Amphibians

1.2.2.1 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 migratory waterfowl 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 waterfowl.

The study aims to conduct ecological assessment of the avifauna in order to establish a baseline of IFAP proposed sites.

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 found in 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 Coliforms, 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

2. MATERIAL AND METHODS

Faunal data were 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 during winter and summer. Detail of survey team is given in the annex document.

2.1.1 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.

2.1.2 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/hour). 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. A fresh rain eliminates the previous tracks and 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 observe and must be flushed to be observed and recorded.

2.1.6 Pellet counts

Pellet 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 m² 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.
How can you convert the number of pellet groups into the 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 populations 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

Active searching

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, Hystrix* 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 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 in a specific area on a line approximately 500 m long; 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 trapped specimens were transferred into polythene bags, 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 was 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.

2.3Reptiles 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 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 herpeto-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 pools, water channels) and suitable microhabitats for both amphibians and reptiles (e.g. stones, pond bunds, crevices, leaf litter/debris, rotten logs).

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 moistre 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.

2.3.4 Signs

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 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.

2.3.7Preservation

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 mentholated 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:

$D = - \Sigma\ p_i$ in p_i, where "i" stands for an index number for each species present in a sample, "p_i" can be calculated through "n_i/N" in which "n_i" 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 "p_i" of each species in the sample times the natural log of that same value "ln p_i" 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 type in the study area available for birds was identified. The species and number of birds of each species found in each habitat type was recorded with particular emphasis on the key species. The data were also related to other components of the study area such as vegetation, water and soil etc. The field surveys covered both migratory and breeding birds.

The most commonly used field method in bird surveying is the "Line Transect" 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, 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 will be 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 (12).

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.

The sample was also collected for microbiological analysis of the water source of the Kharochann area.

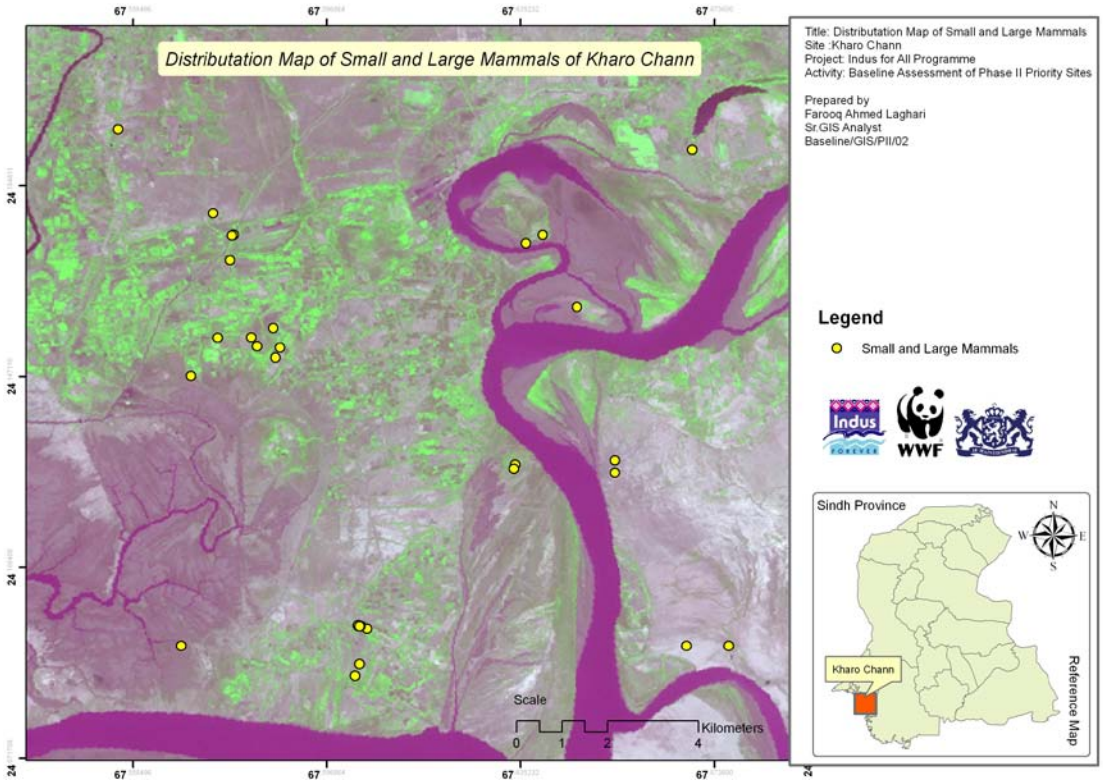
CHAPTER 3: RESULTS AND DISCUSSION

3.1 Large Mammals

3.1.1Sampling locations

Almost all the potential sites around Kharochann were searched to locate the existing large mammals and the GPS coordinates at different locations were noted. Different sampling sites around Kharochann during winter and summer surveys are given in Maps 2 and 3. GPS coordinates taken during surveys are given in annex document.

Map 2 – Sampling sites of large mammals at Kharochann



3.1.2 Species identified

During winter surveys in November 2010, a total of 15 animals of 10 different species, belonging to three orders (Carnivora (8 species), Artiodactyla (one species) and Pholidata (one species)) were observed in the study area, as given in Table 1 below:

Table 1 – Large Mammals recorded from Kharochann

S. No	Common Name	Scientific Name	Order	Animals Observed
1	Asiatic jackal	*Canis aureus*	Carnivora	3
2	Jungle cat	*Felis chaus*	Carnivora	1
3	Fishing cat	*Prionailurus viverrinus*	Carnivora	-
4	Desert cat	*Felis silvestris*	Carnivora	-
5	Bengal fox	*Vulpes bengalensis*	Carnivora	-
6	Small Indian mongoose	*Herpestes javanicus*	Carnivora	5
7	Grey mongoose	*Herpestes edwardsi*	Carnivora	1
8	Small Indian Civet	*Viverricula indica*	Carnivora	-
9	Indian wild boar	*Sus scrofa*	Artiodactyla	4
10	Indian pangolin	*Manis crassicaudata*	Pholidata	1

3.1.1 Observation Records

Out of ten recorded species of large mammals, five were observed directly while five species were recorded on the basis of indirect evidences like tracks/foot prints and interviews of locals. Observation records of different mammalian species at Kharochann are given in the Table 2 below.

TABLE 2 Observation records of different mammal species at Kharochann

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	Bengal fox	-	-	-	✓
6	Small Indian mongoose	✓	-	-	✓
7	Grey mongoose	✓	-	-	✓
8	Small Indian Civet	-	-	-	✓
9	Indian wild boar	✓	✓	-	✓
10	Indian pangolin	-	-	-	✓

3.1.2 Conservation Status of Recorded Mammals

Out of 10 recorded species, one is Near Threatened, two Vulnerable (VU) and seven Least Concern (LC) according to the IUCN Red List 2011. Three species are listed in Appendix I of CITES and five in Appendix II of CITES, as listed in Table 6. Appendix I of CITES lists species that are the most endangered and CITES prohibits international trade in specimens of these species. Appendix II lists the species that are not threatened now but may become so unless trade is closely controlled.

Species listed in Sindh Wildlife Protection Ordinance 1972 not mentioned in the text.

Table 3 – Conservation status of mammals found at Kharochann

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	Bengal fox	LC		Appendix I
6	Small Indian mongoose	VU		Appendix II
7	Grey mongoose	LC		
8	Small Indian Civet	LC		Appendix I
9	Indian wild boar	LC		Appendix I
10	Indian pangolin	NT	P	Appendix II

Legend: NT = Near Threatened, VU = Vulnerable, LC = Least Concern, P = Protected

3.1.5Threats and recommendations

3.1.5.1 Threats

- **Persecution of wildlife:** Species such as jackals and jungle cats prey upon poultry and therefore locals shoot or trap these species. Similarly wild boar destroys their crops and they shoot them whenever they get a chance.
- **Food competition:** Hundreds of feral dogs in the area are not only a problem for the local residents but also for wild animals. These are the major food competitors for most of the carnivore species in the area. Wild animals like jackal, jungle cat, fishing cat etc. are facing threats from the local people as they consider them problem species. Feral dogs on the contrary, having been sheltered by locals, face

no problems at all and thus offer a real food competition for wild animals near human habitations as well as away from them;

- **Lack of awareness:** Usually the local people are not familiar with the wildlife, its positive role and ecological importance. Killing, hunting and trapping of wild animals is the result of such unawareness and a hurdle in wildlife conservation.
- **Pollution:** Excessive pollution in creek system is resulting in the unavailability of food for marine life as well as habitat degradation. The creek system receives untreated upland runoff, coastal dumps and domestic sewage which drain into creeks. Marine pollution mostly consists of synthetic materials causing degradation of marine environment. The oil and oil dispersants from the boats are also source of water pollution, all of which affect the marine environment.

3.1.5.2 Recommendations

- Control of Feral dog population: Feral dog population is dominating the wildlife population and is a threat to the wildlife population. They sometimes bite the humans also and therefore a threat to humans as well. There should be check on population of feral dogs in the area.
- Awareness raising campaign: Local people are not familiar with the wildlife and its ecological role. Therefore, there is a need for raising awareness among general public about the importance of wildlife and its role in the ecosystem.
- Pollution control: The locals may be educated about the hazards of pollution and they may be provided proper space to dispose of the wastes including boat oils instead of draining into sea.

3.2 Small Mammals

3.2.1 Observation locations

Map below shows the sampling locations of small mammal survey at Kharochann. Further details of the sampling points can be found in the annexure document.

Map 3 – Details of trapping locations for small mammals at Kharochann

3.2.2 Species account

Nine small mammal species were observed. The species belonged to two orders (Rodentia and Lagomorpha) and 4 families. Table 11 gives an account of the species recorded at Kharochann along with their status, feeding habits and activity habits.

Follow a similar format in all data Tables

Table 4 – Small Mammal Species recorded at Kharochann along with conservation status, feeding and activity habits in ??????????? 2010

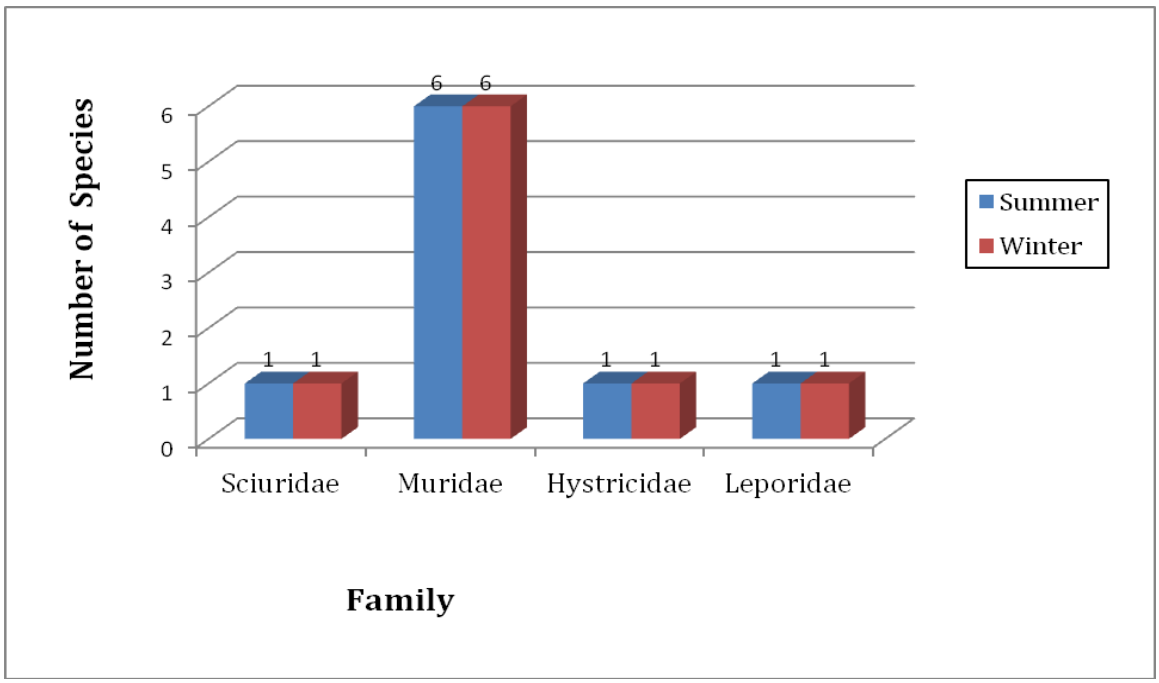
S. No	Scientific Name	English Name	Feeding Habit	Behavior	Status	Winter	Summer

Order: Rodentia							
Family: Sciuridae							
1	*Funambulus pennanti*	Palm Squirrel	GRN	DR	C	4	7
Family: Muridae							
2	*Gerbilus nanus*	Balochistan Gerbil	GRN	NC	C	1	2
3	*Rattus rattus*	Common Rat	GRN	NC	C	2	1
4	*Mus musculus*	Common House Mouse	GRN	NC	C	2	3
5	*Bandicota bengalensis*	Indian Mole Rat	GRN	Mostly DR	C	5	2
6	*Tatera indica*	Indian Gerbil	GRN	NC	C	2	6
7	*Meriones hurrianae*	Indian Desert Jird	GRN	DR	SC	5	6
Family: Hystricidae							
8	*Hystrix indica*	Indian crested porcupine	HRB	NC	C	1	3
Order Lagomorpha							
Family Leporidae							
9	*Lepus nigricollis*	Desert hare	HRB	NC	C	1	2

[Legend: GRN = Grainivore, HRB = Herbivore, NC = Nocturnal, DR = Diurnal, C = Common, SC – Scarce]

Figure 1 below shows the number of species recorded from each family. As can be seen most of the species belong to Muridae family (66%). There was no major change in distribution of families during winter and summer, suggesting that there is little migration of animals over the seasons. Since there are no population figures available, it is hard to predict whether any of the small mammal populations increased or decreased over the study period.

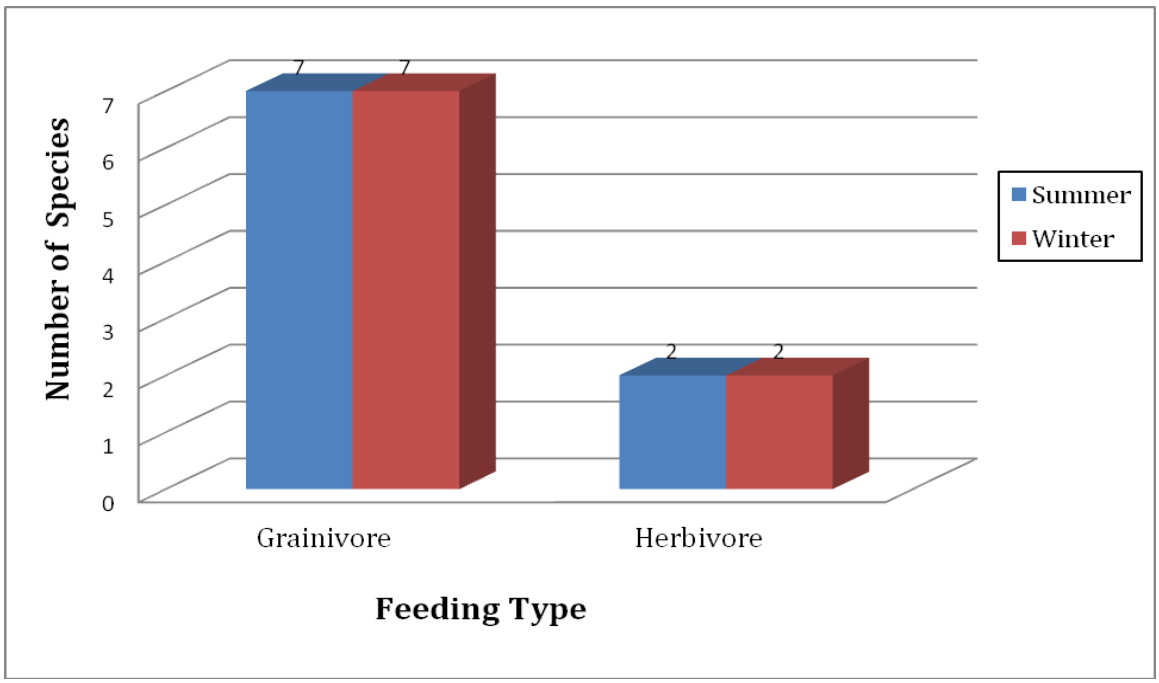
Figure 1 – Family representation of recorded small mammals at Kharochann



3.2.3 Feeding habits

Most of the species recorded from Kharochann are grainivore (seven) followed by herbivore (two). Figure 2 gives a graphical portrayal of the number of species over feeding habits.

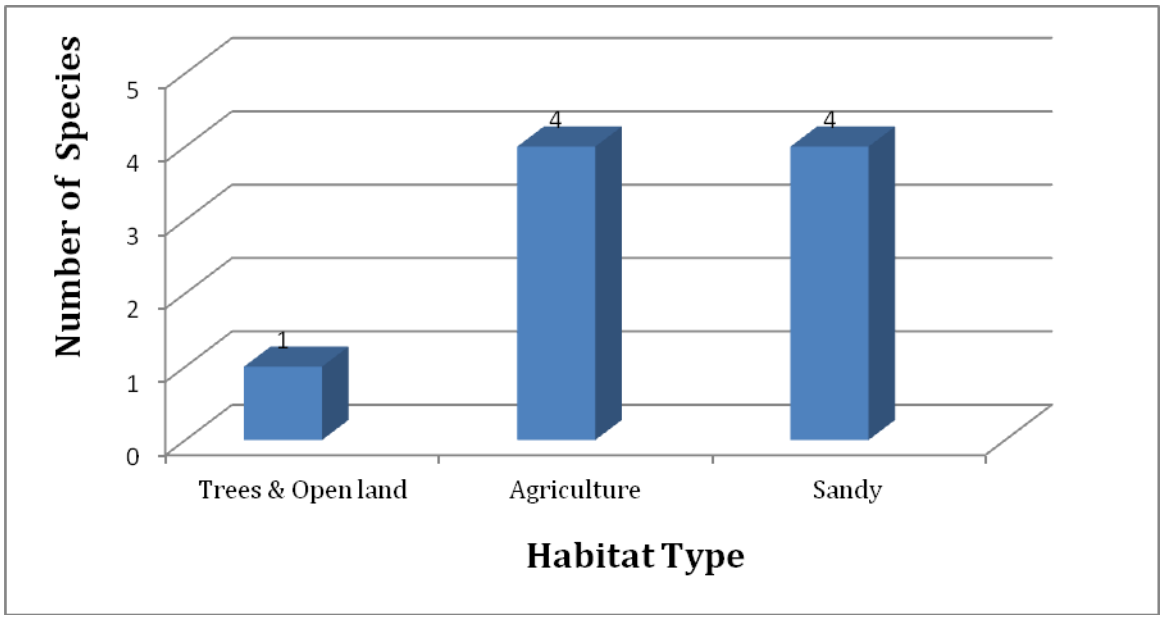
Figure 2 – Distribution of feeding types across the species recorded at Kharochann



3.2.3 Habitat and occurrence

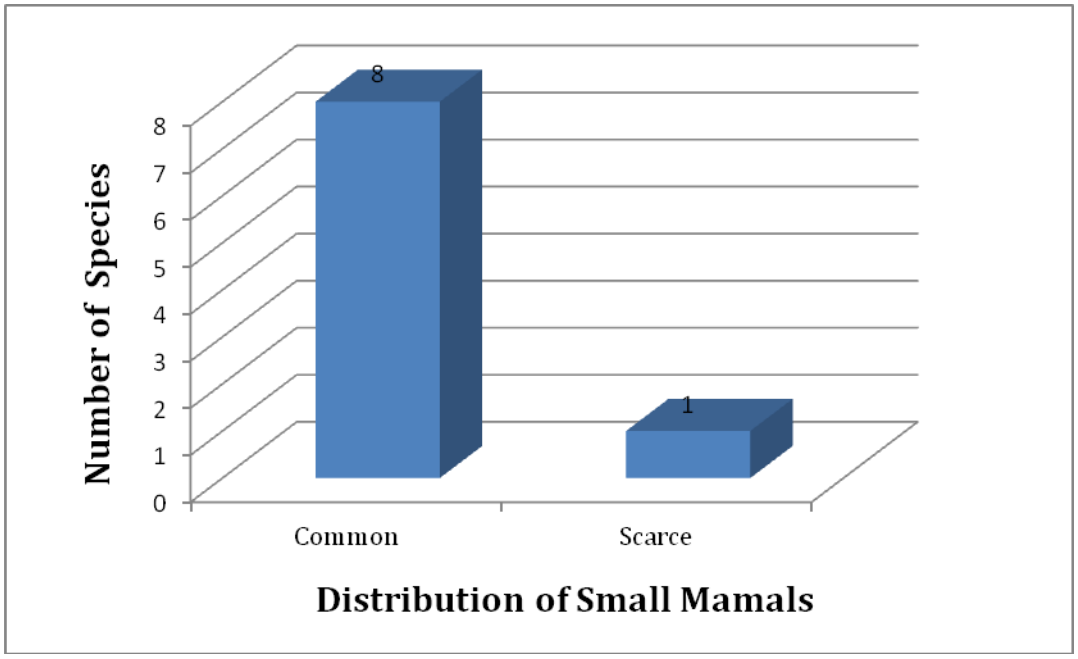
The majority of the species were recorded from agriculture land (as shown in Figure 3) followed by open land habitat. Any similarities between the results of feeding habits and habitat occupancy are probably correlated.

Figure 3 – Number of species recorded from habitat types



Out of the total species recorded from Kharochann all species except one are common. The numbers do not reflect the status of each species at site level which requires longer term studies.

Figure 4 – Distribution of small mammal status by species and seasons at Kharochann; Common=8, Scarce=1



3.2.5 Threats and recommendations

3.2.5.1 Threats

- Extensive farming and application of agro-chemicals are contaminating the agriculture land and associated micro-habitats such as marginal lands in the area. Such contamination is known to directly and indirectly impact small mammal population through direct poisoning and reduction of food source, especially in the case of insectivores.
- The presence of a substantial feral dog population (unknown figure) in the area may be having a detrimental effect on the local small mammal species. The dogs probably are additional predators to small mammals and themselves have no predators.
- Hunting of Desert hare is common which is done throughout the year. This is the cause of decline of the population of this species.

3.2.5.2 Recommendations

- Farmers/Agriculturists should be made aware of the importance of small mammal as natural pest controllers and be given instructions on wise-use of pesticides and other agro-chemicals on farm land;
- Some attempts should be made to control the feral dog population in and around Karochann. This would not only remove some of the pressure on small mammal population but would bring benefit to a lot of the wildlife in the region;
- Mark and recapture studies (Lincoln index) should be undertaken for selected small mammal species. This would help in monitoring the local population of selected small mammal as an indicator of the ecosystem.

3.3 Reptiles and amphibians

3.3.1 Sample locations

Map 4 below shows the details of trapping locations of reptiles and amphibians from Karochann. Details of sampling points can be found in the annexure document.

Map 4 – shows the sampling/trapping location for reptiles and amphibians at Kharochann

3.3.2 Summary

Kharochann is a Taluka (Tehsil) of Thatta District, situated at a distance of about 220 km SE of Karachi. It is located in Indus delta and represents a diverse habitat complex supporting amphibians and reptiles. The area is wide and consists of several Dehs (clusters of villages). There are six major creeks in the area *viz.* Chann, Rohra, Ghora, Khichry, Mal and Wari creeks with innumerable small creeks.

Survey of herpeto-fauna was undertaken in November 2010 in different villages including Phat, Khair Muhammad Shah, Tharewari, Sajanwari, Marvi jo Goth, Kori Dhand, Jangisar, Atharki, Goth Saleh Solangi, Saleh Dandal, Lado Khaskheli, Chann creek, Goth Muhammad Rahim Shah and Bhagan. Both diurnal and nocturnal surveys were conducted in the area.

Eleven species of Reptiles (3 orders and 8 families) and three species of Amphibians (one order and 2 families) were recorded. These species were also classified on the basis of food habits; 7 species were insectivores, 6 carnivores and one herbivore.

The status of species was determined at the local level. Those species which were sighted frequently in a habitat or had visible signs of its occurrence and considered to be common by the local people has been categorized as 'Common'. The species which was occasionally sighted and had least visible signs of its occurrence was classified as 'Scarce or Rare'. According to this categorization, 10 species were common and 4 rare or scarce.

During a survey conducted by IFAP in 2008, 18 species were collectively recorded from Keti Bunder and Kharochann. Recent massive flood in the area displaced ground dwelling creatures like reptiles. It has been observed that lizards were the most affected animal. During flood many snake species were killed by locals when they came out from their burrows. However, Indian monitor *(Varanus bengalensis)* was still common in the area.

There are 14 species of marine snakes reported from Pakistan (Khan 2006). Most of the species inhabit mangrove swamps and mouth of Indus. They could be found in the sea water in Kharochann area. Similarly, marine turtles may also visit the sandy beaches but this requires further investigation.

The number of amphibian and reptilian species is seemingly less than what will be the actual occurrence in the area but due to some limitations the reported species may be less. The survey period was very brief and surveys in most of the areas could not be undertaken. This survey intended to provide preliminary data and status of the reptiles and amphibians of the area.

Table 5: Reptilian and Amphibian Species of Kharochann

	English Name	Scientific Name	Status	Activity Pattern	Feeding Habits	Summer	Winter
Reptiles							
Order Chelonia							
Family Emydidae							
1	Saw-back turtle	*Kachuga tecta*	C	Diurnal	HRB	1	1
Order Sauria							
Family Agamidae							

2	Tree Lizard or Indian Garden Lizard	*Calotes v. versicolor*	C	Diurnal	INS	6	3
6	Afghan Ground Agama	*Trapelus megalonyx*	C	Diurnal	INS	3	1
Family Varanidae							
3	Bengal monitor	*Varanus bengalensis*	C	Diurnal	CAR	4	2
Family Scincidae							
4	Bronze Grass Skink	*Eutrophis macularia*	C	Diurnal	INS	4	1
Family Gekkonidae							
5	Yellow-bellied House Gecko	*Hemidactylus flaviviridis*	C	Nocturnal	INS	8	4
Order Serpentes							
Family Elapidae							
7	Black Cobra	*Naja naja naja*	R	Mostly Diurnal	CAR	2	1
8	Indian or Common Krait	*Bungarus caeruleus*	R	Nocturnal	CAR	2	1
Family Viperidae							
9	Saw scaled Viper	*Echis carinatus*	C	Nocturnal	CAR	1	1
Family Colubridae							
10	Afro Asian Sand Snake	*Psammophis s. schokari*	R	Nocturnal	CAR	1	1
11	Rope Snake or Dhaman	*Ptyas m. mucosus*	R	Nocturnal	CAR	1	1
Amphibians							
Family Ranidae							
12	Bull frog	*Hoplobatrachus tigerinus*	C	Nocturnal	INS	2	1
13	Skittering Frog	*Euphlyctis c. cyanophlyctis*	C	Non-specific	INS	4	4
Family Bufonidae							
14	Indus valley toad	*Bufo tomaticus*	C	Mostly nocturnal	INS	8	5

[Legend: CAR = Carnivore, HRB = Herbivore, INS = Insectivore, C = Common, R – Rare]

3.3.3 Species richness

Species Richness (s) is a relative term that refers to the number of species in a community, and is directly associated with measuring the diversity of species in a given area. A related term, evenness (E), is another dimension of diversity that defines the

number of individuals from each species in the same area. Together, these terms have been used to describe species diversity patterns on Earth.

There are several hypotheses that have been proposed to explain species diversity patterns. Many of these hypotheses are based upon the idea that species are more diverse near the equator than near the poles. In other words, there is a recognized latitudinal gradient of species diversity on Earth. The hypotheses that support this latitudinal gradient can be divided into two groups: abiotic and biotic. The biotic hypotheses are those that explain species diversity patterns with relation to living organisms. The abiotic hypotheses, on the other hand, explain species diversity patterns with relation to non-living chemical and physical environmental factors.

Table 8 gives four indices of richness starting with the number of species (graphically shown in Figure 5). Evenness and two biodiversity indices are also given in the table, namely Shannon's and Margalef.

Shannon's Index
The Shannon-Weaver diversity index looks at how a species is distributed in an ecosystem. To perform this calculation, you need to sample a population by taking a look at a given area, counting different species in the population and assessing their abundance. The Shannon-Weaver diversity index is also known as the Shannon index or Shannon-Wiener index. This is an important measurement for biodiversity.

Let's use our sample data (14 species, 47 total individuals) and calculate D i.e. Shannon Index for summer:

Species	Afghan Ground Agama	Bengal monitor	Saw back turtle	Yellow-bellied House Gecko	Bronze grass skink	Black Cobra	Indian or common krait
n_i (population size)	3	4	1	8	4	2	2
p_i	0.214	0.286	0.071	0.571	0.286	0.142	0.142
$\ln p_i$	-1.54	-1.25	-2.64	-0.56	-1.25	-1.95	-1.95
$p_i \times \ln p_i$	-0.33	-0.36	-0.19	-0.32	-0.36	-0.28	-0.28

Skittering Frog	Saw scaled viper	Afro Asian sand snake	Rope snake or Dhaman	Bull frog	Indian Garden Lizard	Indus valley toad	Total = N
4	1	1	1	2	6	8	47
0.286	0.071	0.071	0.071	0.142	0.429	0.571	
-1.25	-2.64	-2.64	-2.64	-1.95	-0.85	-0.56	
-0.36	-0.19	-0.19	-0.19	-0.28	-0.36	-0.32	$-4.01 = \Sigma$

S = 14 species
N = 47 individuals
$D = -\Sigma p_i \ln p_i = -1 \times -4.01 = 4.01$

Remember: The value of D is highest when species are equally abundant.

Let's use our sample data (14 species, 27 total individuals) and calculate D i.e. Shannon Index for winter:

Species	Afghan Ground Agama	Bengal monitor	Saw back turtle	Yellow-bellied House Gecko	Bronze grass skink	Black Cobra	Indian or common krait
n_i (population size)	1	2	1	4	1	1	1
p_i	0.071	0.142	0.071	0.286	0.071	0.071	0.071
$\ln p_i$	-2.64	-1.95	-2.64	-1.25	-2.64	2.64	-2.64
$p_i \times \ln p_i$	-0.19	-0.28	-0.19	-0.36	-0.19	-0.19	-0.19

Skittering Frog	Saw scaled viper	Afro Asian sand snake	Rope snake or Dhaman	Bull frog	Indian Garden Lizard	Indus valley toad	Total = N
4	1	1	1	1	3	5	27
0.286	0.071	0.071	0.071	0.071	0.214	0.357	
-1.25	-2.64	-2.64	2.64	-2.64	-1.54	-1.03	
-0.36	-0.19	-0.19	-0.19	-0.19	-0.33	-0.37	$-3.41 = \Sigma$

S = 14 species
N = 27 individuals
$D = -\Sigma p_i \ln p_i = -1 \times -3.41 = 3.41$

Remember: The value of D is highest when species are equally abundant.

Species Evenness

The diversity of species in a particular area depends not only on the number of species found, but also on their numbers. Ecologists call the number of species in an area its richness, and the relative abundance of species its evenness. They are both measures of diversity.

Divide Shannon's diversity index H by natural logarithm of species richness ln (S) to calculate the species evenness. Note that species evenness ranges from zero to one, with zero signifying no evenness and one, a complete evenness.

E = D/ log (S)

Therefore for summer it is: E = D/ Log(S) = 4.01/ log(14) = 1.52

For winter it is: E = D/ Log(S) = 3.41 / log (14) = 1.29

Margelef Index
It is a measure of species diversity. It is calculated from the total number of species present and the abundance or total number of individuals; the higher the index the greater the diversity.

Da = (S-1) / log to base e N
Where Da = Margalef Index
S = No. of Species
N = Total No. of Individuals
e = 2.7 (constant),

Therefore for Summer it will be: Da = (S-1) / log to base e N
Da = 14-1 / log (2.7 * 47)
= 13 / log (126.9) = 13 / 4.84
= 2.69

For Winter it will be: Da = (S-1) / log to base e N
Da = 14-1 / log (2.7 * 27)
= 13 / log (72.9) = 13 / 4.29
= 3.03

Table 6 – Diversity indices for reptiles and amphibians recorded from Kharochann

S. No.	Index type	Summer	Winter
1	Richness (number of species)	14	14
2	Evenness	1.52	1.29
3	Shannon index	4.01	3.41
4	Margalef index	2.69	3.03

Evenness of the species in both the seasons i.e. in summer and in winter is almost same, however summer figure in Margalef index is little bit higher; it is because more reptile species come out during summer while in winters they hibernate.

Figure 5 – Number of reptile and amphibian species recorded during summer and winter from Kharochann

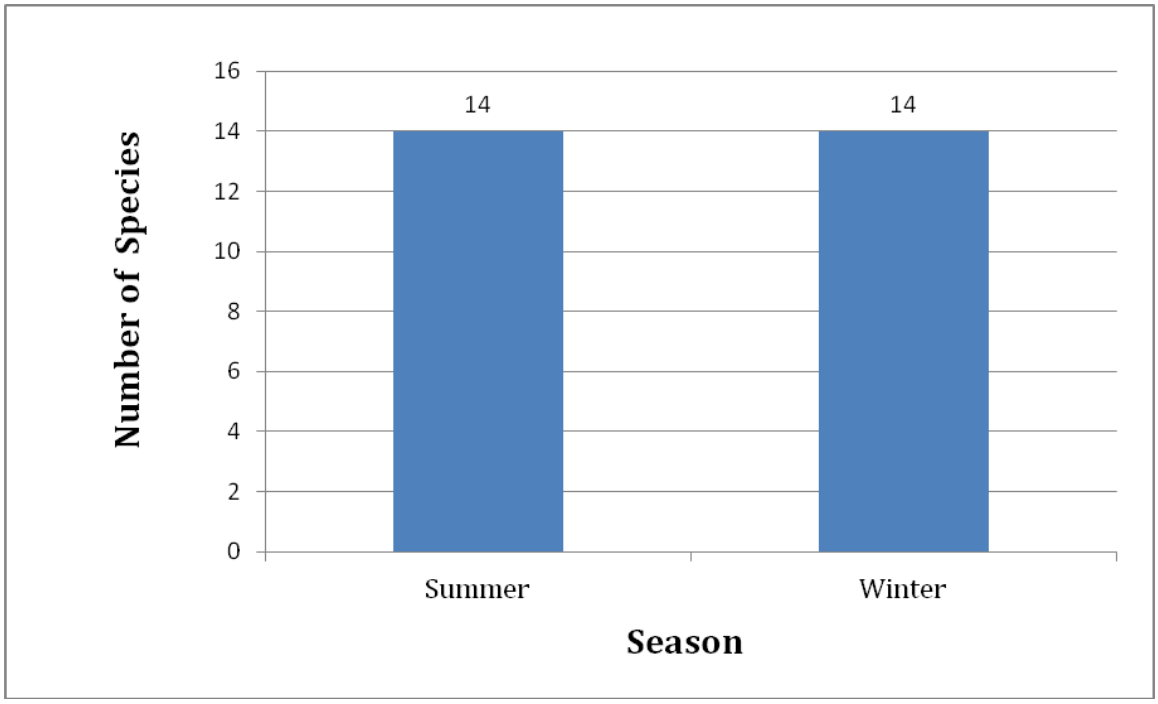


Figure 6 – Evenness of species recorded over summer and winter from Kharochann

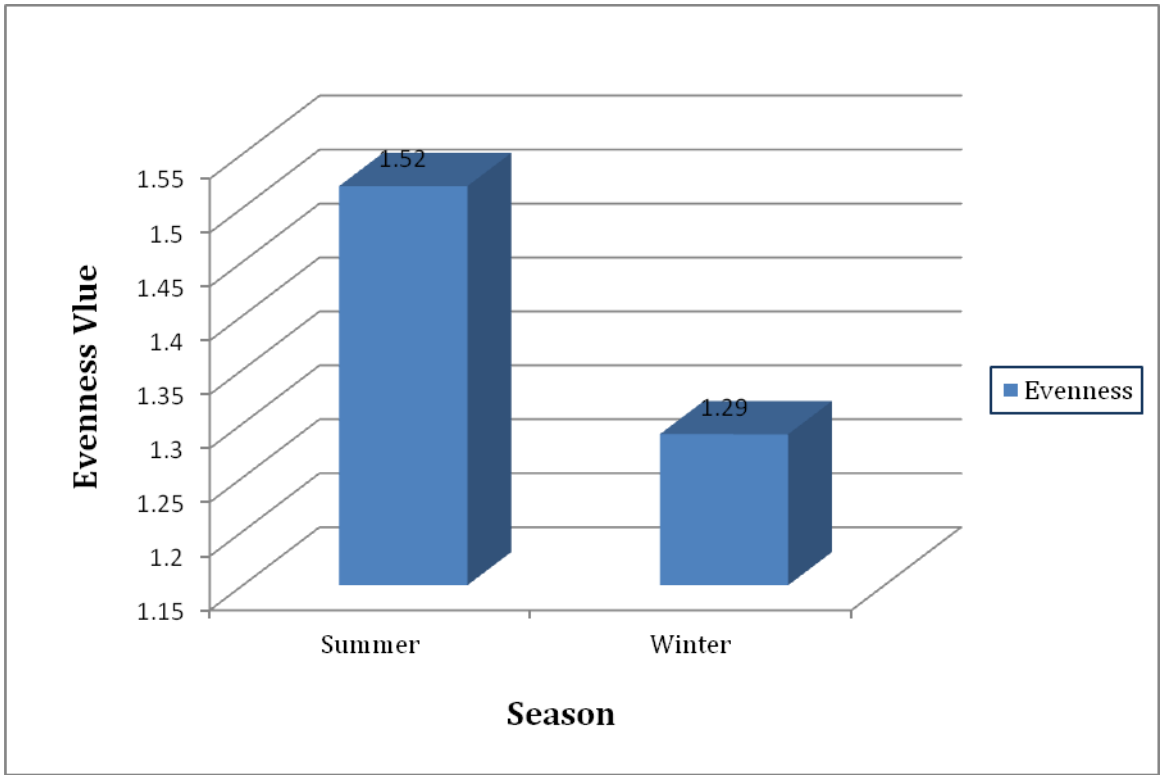
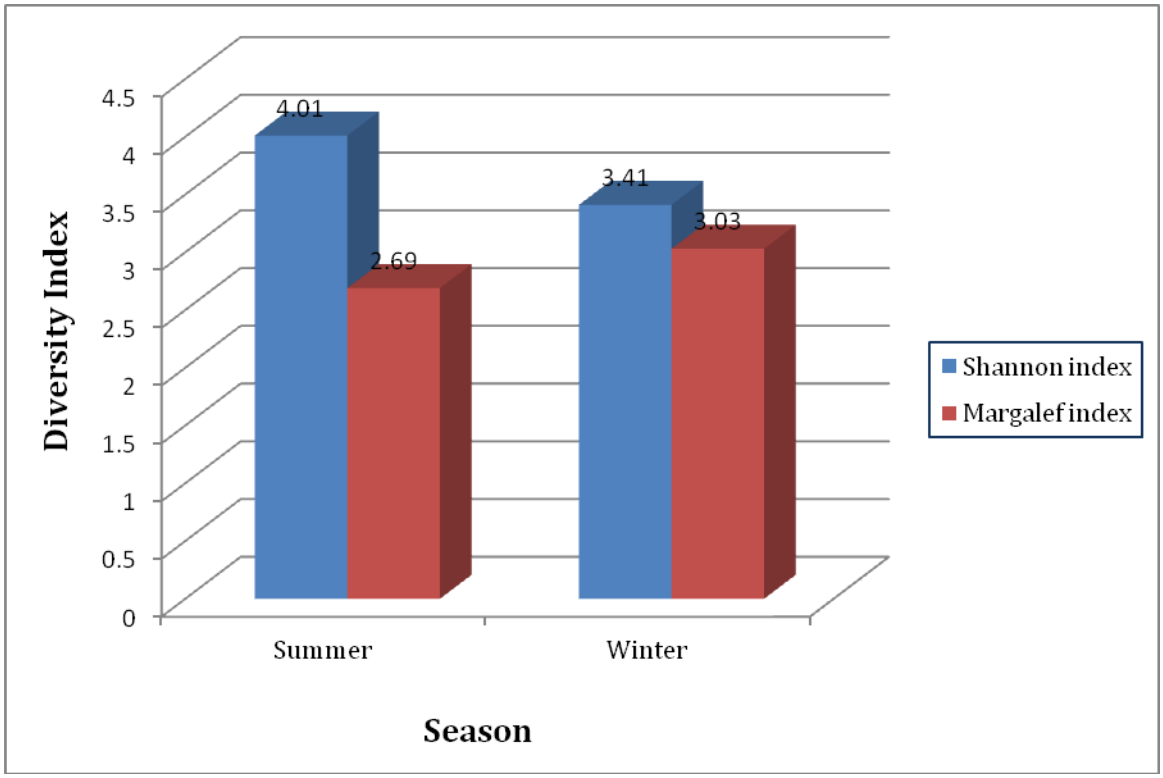


Figure 7 – Shannon and Margalef indexes for summer and winter at Kharochann



3.3.4 Discussion

Same number of species of reptiles and amphibians were recorded in summer and winter at Kharochann. The numbers were however less in winter. The reptiles and amphibians usually hibernate in winter so it is not an unusual phenomenon.

3.3.5 Threats and recommendations

3.3.5.1 Threats

- All the lizards and snakes are regarded as poisonous by the locals and thus are killed at sight, without considering its impacts, ultimately decreasing the herpetile population;
- Some of the endangered reptilian species which are included in IUCN categories, are killed on roads by vehicles. The road-kills of *Varanus* species (Monitor lizards) and fresh water turtles are self-evident and are increasing at a rapid scale due to infrastructure and road construction;

- Jogies, Bar and Bheel communities collect reptiles illegally for selling to the traders based in Karachi who are involved in illegal export of reptiles to other countries;
- Due to lack of proper sewage water and solid waste disposal systems, Kharochann area is heavily polluted. Extensive farmland and agricultural activities are causing pesticides contamination in the sea and ground water, keeping the marine fauna as well as population of Kharochann at risk.

3.3.5.2 Recommendations

- Public awareness regarding the natural resources of the area, their current status and sustainable utilization should be highlighted through workshops, seminars, posters, pamphlets and brochures. Efforts should be made to make possible the community and game watchers' participation in such activities;
- Jogi, Bheel and Bar communities are sweeping the reptiles in the area so they should be motivated to leave this practice. There is need to initiate a community mobilization and awareness raising programme in the area. The local community when mobilized will ultimately prevent the minority community of Jogi and Bheel etc. who mostly come from outside involved in illegal trapping of reptiles.
- A comprehensive and regular survey of reptiles in the area may be undertaken at regular intervals for two years in order to ascertain the status of reptiles in the area;
- Establishment of small research grants to the young researchers and university students for different herpetological surveys of economically important species of this area and involving the locals through capacity building will also help in their livelihood improvement;
- To protect and conserve the vital species of amphibians and reptiles, there should always be the signboards on the road, depicting the importance of nearby heavily populated amphibian or reptile species and the speed of vehicles must remain within limits accordingly.

3.4 Birds

3.4.1 Observation locations

Map below show the observation points of bird surveys at Kharochann during summer and winter. Details of observation points can be found in the annexure document.

Map 5 – Sampling sites of birds at Kharochann

The locations visited during the surveys were agriculture fields, fruit orchards, small forest areas having Mesquite, *Salvadora*, *Capparis*, *Typha* and *Phragmites spp.*, mangrove forest, inland coastal belt and creek areas.

3.4.2 Species account

3.4.2.1 Winter and Summer

Table 7 Bird species observed at Kharochann during winter and summer

	English name	Scientific name	Status	Occurrence	Count	
					Winter	Summer
Order Pelecaniformes						
Family Phalacrocoracidae						
1	Little Cormorant	*Phalacrocorax niger*	Common	Resident	20	7
Order Ciconiiformes						
Family Ardeidae						
2	Black Bittern	*Ixobrychus flavicollis*	Scarce	Resident	-	1
3	Grey Heron	*Ardea cineria*	Scarce	Resident	30	4
4	Indian Pond Heron	*Ardeola grayii*	Common	Resident	25	18
5	Cattle Egret	*Bubulcus ibis*	Common	Resident	30	35
6	Large Egret	*Egretta alba*	Scarce	Winter visitor	26	-
7	Intermediate Egret	*Egretta intermedia*	Scarce	Resident	7	-
8	Little Egret	*Egretta garzetta*	Common	Resident	29	10
9	Reef Heron	*Egretta gularis*	Common	Resident	15	10
Family Ciconiidae						
10	Painted Stork	*Mycteria leucocephala*	Rare	Resident	-	2
Order Falconiformes						
Family Accipitridae						
11	Common Kite	*Milvus migrans*	Common	Resident	230	34
12	Blackwinged Kite	*Elanus caeruleus*	Scarce	Resident	4	-
13	Brahminy Kite	*Halistur indus*	Common	Resident	54	38
14	Shikra	*Accipiter badius*	Scarce	Winter visitor	2	1
15	White-eyed Buzzard	*Butastur teesa*	Scarce	Resident	6	1

16	Marsh Harrier	*Circus aeruginosus*	Scarce	Resident	9	-
Family Pandionidae						
17	Osprey	*Pandion haliaetus*	Scarce	Winter visitor	2	-
Order Galliformes						
Family Phasianidae						
18	Grey Partridge	*Francolinus pondicerianus*	Common	Resident	39	6
19	Black Partridge	*Francolinus francolinus*	Scarce	Resident	8	-
Order Gruiformes						
Family Rallidae						
20	White breasted Waterhen	*Amaurornis phoenicurus*	Scarce	Resident	6	1
Order Charadriiformes						
Family Charadriidae						
21	Oystercatcher	*Haematopus ostralegus*	Common	Winter visitor	29	-
22	Red-wattled Lapwing	*Vanellus indicus*	Common	Resident	40	52
23	Little-ringed Plover	*Charadrius dubius*	Common	Winter visitor	16	2
24	Kentish Plover	*Charadrius alexandrinus*	Common	Winter visitor/ oversummering	25	10
25	Lesser Sand Plover	*Charadrius mongolus*	Common	Winter visitor	9	-
Family Scolopacidae						
26	Curlew	*Numenius arquata*	Common	Winter visitor	18	-
27	Whimbrel	*Numenius phaeopus*	Common	Passage Migrant	4	-
28	Bartailed Godwit	*Limosa lapponica*	Common	Winter visitor/ oversummering	42	4
29	Common Redshank	*Tringa tetanus*	Common	Winter visitor	37	-
30	Marsh Sandpiper	*Tringa stagnatilis*	Scarce	Winter visitor	2	-
31	Greenshank	*Tringa nebularia*	Scarce	Winter visitor	3	-
32	Common Sandpiper	*Tringa hypoleucos*	Common	Winter visitor	20	-
33	Little Stint	*Calidris minutus*	Common	Winter visitor	18	-
Family Recurvirostridae						
34	Black-winged	*Himantopus*	Common	Resident	165	10

	Stilt	*himantopus*				
Family Dromadidae						
35	Crab Plover	*Dromas ardeola*	Scarce	Passage Migrant	4	-
Family Laridae						
36	Heuglin's Gull	*Larus heuglinii*	Common	Winter visitor	200	-
37	Brown-headed Gull	*Larus brunnicephalus*	Scarce	Winter visitor	24	-
38	Black-headed Gull	*Larus ridibundus*	Common	Winter visitor/ oversummering	80	7
39	Slender-billed Gull	*Larus genei*	Common	Resident	23	5
40	Caspian Tern	*Hydroprogne caspia*	Scarce	Year Round Visitor	10	2
41	Indian River Tern	*Sterna aurantia*	Common	Resident	28	6
42	Black-bellied Tern	*Sterna acuticauda*	Scarce	Resident	6	-
43	Little Tern	*Sterna albifrons*	Common	Resident	38	13
44	Sandwich Tern	*Sterna sandvicensis*	Common	Year Round Visitor	29	-
45	White-cheeked Tern	*Sterna repressa*	Scarce	Summer visitor	-	4
Order Columbiformes						
Family Columbidae						
46	Blue Rock Pigeon	*Columba livia*	Common	Resident	47	78
47	Ring Dove	*Streptopelia decaocto*	Common	Resident	188	23
48	Little Brown Dove	*Streptopelia senegalensis*	Common	Resident	110	26
Order Cuculiformes						
Family Cuculidae						
49	Crow Pheasant	*Centropus sinensis*	Common	Resident	20	3
50	Common Koel	*Eudynamys scolopacea*	Common	Resident	-	15
Order Psittaciformes						
Family Psittacidae						
51	Rose ringed Parakeet	*Psittacula krameri*	Common	Resident	-	10
Order Coraciiformes						
Family Alcedinidae						
52	Pied Kingfisher	*Ceryle rudis*	Common	Resident	17	25

53	Common Kingfisher	*Alcedo atthis*	Scarce	Resident	3	-
54	Whitebreasted Kingfisher	*Halcyon smyrnensis*	Common	Resident	10	6
Family Meropidae						
55	Green Bee eater	*Merops orientalis*	Common	Resident	29	33
Family Coracidae						
56	Indian Roller	*Coracias benghalensis*	Scarce	Resident	6	-
Order Passeriformes						
Family Alaudidae						
57	Desert Lark	*Ammomanes deserti*	Scarce	Resident	7	-
58	Great Short-toed Lark	*Calendrella brachydactyla*	Scarce	Winter visitor	2	-
59	Crested Lark	*Galerida cristata*	Common	Resident	55	9
Family Hirundinidae						
60	Pale Sand Martin	*Riparia diluta*	Common	Winter visitor	13	-
61	Pale Crag Martin/Rock Martin	*Hirundo fuligula*	Scarce	Resident	2	-
62	Barn or Common Swallow	*Hirundo rustica*	Common	Winter visitor	20	-
63	Wire-tailed Swallow	*Hirundo smithi*	Common	Resident	-	15
Family Laniidae						
64	Rufous tailed or Isabelline Shrike	*Lanius isabellinus*	Scarce	Winter visitor	8	-
65	Southern Grey Shrike	*Lanius meridionalis*	Scarce	Resident	4	-
Family Dicruridae						
66	Black Drongo	*Dicrurus adsimilis*	Common	Resident	29	5
Family Sturnidae						
67	Indian Myna	*Acridotheres tristis*	Common	Resident	37	41
68	Bank Myna	*Acridotheres ginginianus*	Scarce	Resident	-	9
Family Corvidae						
69	House Crow	*Corvus*	Common	Resident	35	86

		splendens				
Family Pycnonotidae						
70	White-cheeked Bulbul	*Pycnonotus leucogenys*	Common	Resident	48	52
Family Timaliidae						
71	Common Babbler	*Turdoides caudatus*	Common	Resident	22	49
Family Rhipiduridae						
72	White browed Fantail Flycatcher	*Rhipidura aureola*	Scarce	Resident	4	-
Family Sylviidae						
73	Common Chiffchaff	*Phylloscopus collybita*	Common	Winter visitor	17	-
Family Turdidae						
74	Pied Bush Chat	*Saxicola caprata*	Common	Resident	16	10
75	Isabelline Wheatear	*Oenanthe isabellina*	Scarce	Winter visistor	2	-
76	Desert Wheatear	*Oenanthe deserti*	Scarce	Winter visitor	4	-
77	Hume's Wheatear	*Oenanthe alboniger*	Scarce	Resident	2	-
78	Indian Robin	*Saxiculoides fulicata*	Scarce	Resident	4	-
Family Motacillidae						
79	White Wagtail	*Motacilla alba*	Common	Winter visitor	18	-
80	Yellow Wagtail	*Motacilla flava*	Common	Passage Migrant	25	-
81	Paddy-field Pipit	*Anthus rufulus*	Scarce	Resident	-	4
Family Nectariniidae						
82	Purple Sunbird	*Nectarinia asiatica*	Common	Resident	10	34
Family Passeridae						
83	House Sparrow	*Passer domesticus*	Common	Resident	160	82
84	Sind Jungle Sparrow	*Passer pyrrhonotus*	Common	Resident	38	-
85	Streaked Weaver Bird	*Ploceus manyar*	Common	Resident	-	36
TOTAL					2424	934

3.4.3 Summer and winter

A total of 85 species of birds belonging to 11 orders and 32 families were recorded. Among them in winter, 76 species belonging to 10 orders and 31 families were recorded whereas in summer 47 species of birds belonging to 11 orders and 23 families were recorded. The total number of birds counted in winter was 2,424 and in summer it was 934. 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 in the winter.

Among the total species of birds recorded, 54 were resident, 25 winter visitors, 1 summer visitor, 3 passage migrants and 2 year round visitors. There were 3 species which were primarily winter visitor but found to be over-summering in the area. The status of birds found in the area was derived on the basis of their occurrence in this area denotes <5 as rare, 6 to 15 as scarce, and >15 as common. On the basis of the developed criteria, 49 species were common, 16 rare and 20 scarce.

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.

Figure 8 – Number of species, families and orders observed during winter and summer season

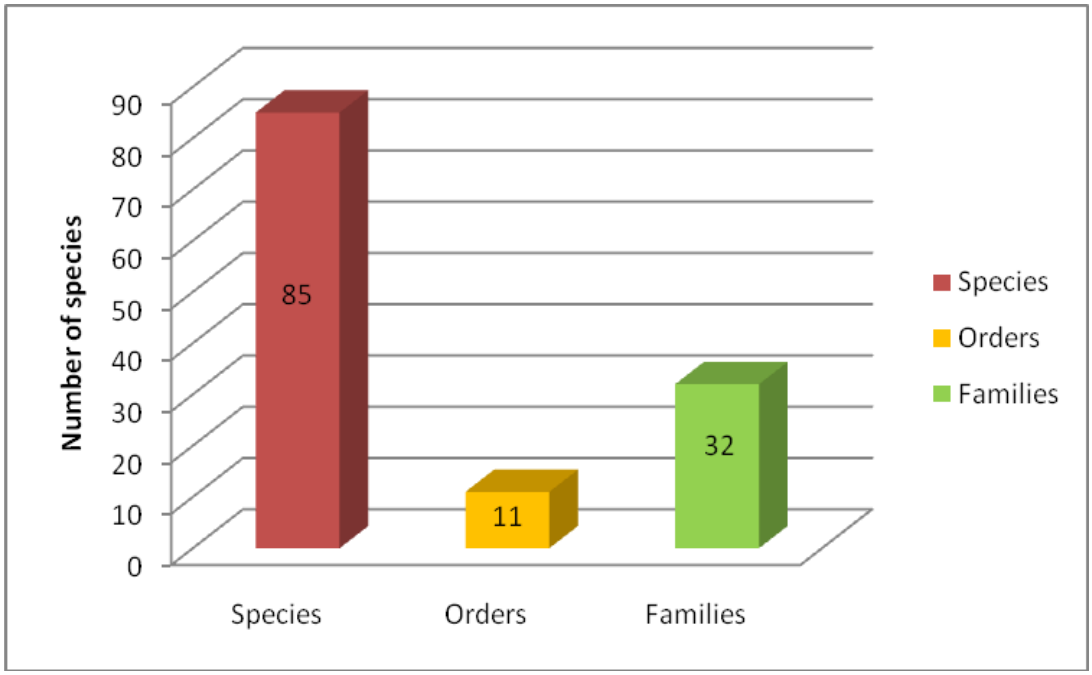


Figure 9 – The abundance of the number of species during the summer and winter season

Figure 10 – Representation of birds recorded during the two seasons

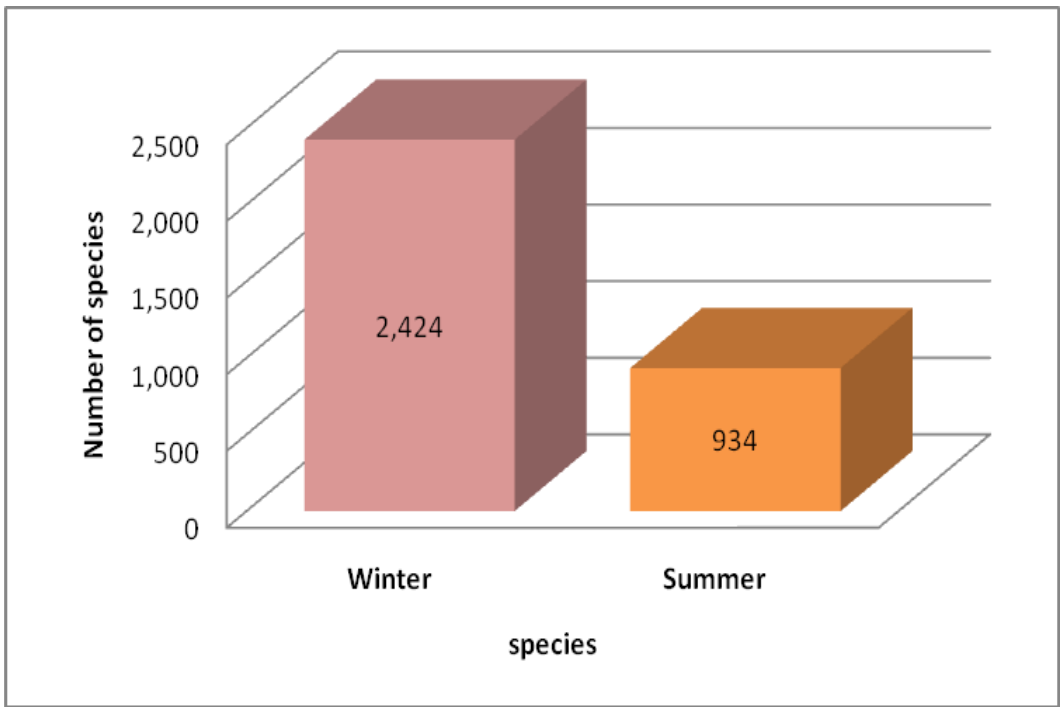
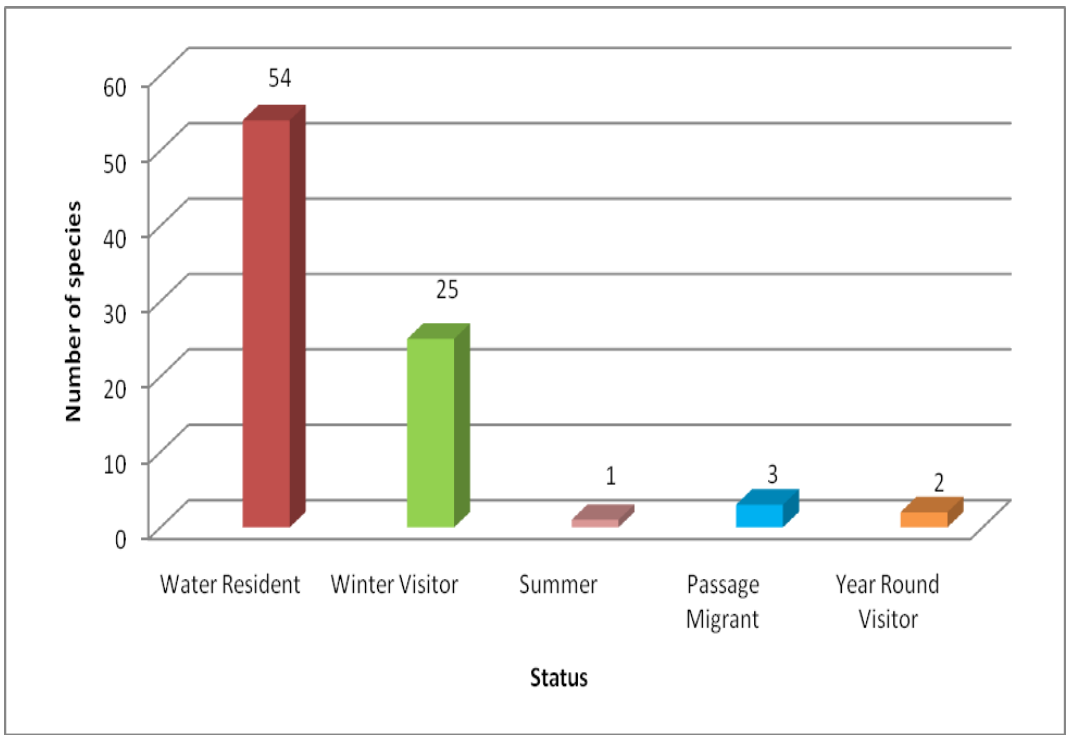


Figure 11 – Number of bird species recorded from Kharochann by seasons and occurrence



3.4.4 Threats and recommendations

3.4.1 Threats

- Hunting and poaching of birds is a major threat in the area.
- Degradation of habitat, primarily mangroves has deprived many species of breeding and feeding grounds. Some birds are unable to nest in creeks due to lack covers.
- The presence of feral dogs in the area is probably having an effect on the local bird population, especially terrestrial nesting birds.

3.4.2 Recommendations

- The entire aquatic and terrestrial biodiversity need to be conserved particularly the mammals, water-birds and mangroves. Protecting the existing mangroves should be a priority.
- An attempt should be made to control the feral dog population in and around Kharochann. This will not only help conserve the bird population but will help wildlife in general.

3.5 Physico-chemical Properties of Water

3.5.1 Sample Location

The following Map shows the sampling location of water quality for Kharochann [Map to be provided by Laghari Sahib]

3.5.2 Field Observations during water sampling

Drinking water is not easily available to the local people. Both underground and surface resources have been degraded by the sea intrusion. The agriculture run off is drained into sea and solid wastes are also dumped into sea causing pollution in water.

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. One sample was collected from Kharochann area. The result of the analysis is given in Table below:

S. No.	Parameters	Unit	NSDWQ	Concentration	Method	Remarks
1	pH value		6.5 – 8.5	7.70	pH meter	
2	Chloride	mg/l	>250	2678.1	APHA 4500 Cl C	Higher
3	Conductivity	µS	-??????	9310	Conductivity meter	
4	Turbidity	NTU	5	81	Merck Method (077)	Higher
5	Total Hardness	mg/l	<500	1000.4	APHA 2340 C	Higher
6	Total Alkanity	mg/l	-	106.7	APHA 2320 B	
7	Cr (Hexa)	mg/l	0.05	0.01	Hach Method 8023	
8	Lead	mg/l	<0.05	BDL	AAS	
9	Zn	mg/l	5.0	BDL	AAS	
10	COD	mg/l	-	18	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

The Microbiological analysis of the water of Kharochann was undertaken and the result is as under:

S. No.	Parameters	Recommended Value [as per WHO/USEPA for Drinking Water]	Results
01	Faecal Coliform	0 cfu/100 ml	64 cfu/100 ml

3.5.4 Discussion

The main source of fresh water in Kharochann is hand pumps and wells. 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 water quality of Kharochann is not suitable for human consumption as it is highly turbid and also has salt concentration. The presence of Faecal Coliform, the bacteria in water shows the contamination of water with pathogens. It is present with high concentration much above the recommended value of WHO for drinking water. This is why the locals mostly suffer from the water borne diseases.

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 four 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 less active comparatively during the winter surveys. The reasons seem to be the homoeothermic and the hibernation factors for less activity of mammals during winter.

The population estimation of animals was not attempted during this preliminary study. Estimating population of mammals required large efforts and more time than allocated.

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 etc. at different sites are also important factors in wildlife conservation and management in the study area.

Species identified

During surveys 13 large and medium sized mammal species belonging to three orders (Carnivora, Artiodactyla, and Pholidota) 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 8- 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*	Lunher	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 mammal species recorded at all the four sites are given in the table 9.

Table 9- Observation records of Large mammals

S. No.	Species	Direct Observations				Indirect observations through tracks, feces and interviews of local people			
		NWC	ML	KC	KF	NWC	ML	KC	KF
1	Asiatic Jackal	✓	✓	✓	✓	✓	✓	✓	✓
2	Jungle Cat	✓	✓	✓	✓	✓	✓	✓	✓
3	Fishing Cat					✓		✓	
4	Desert Cat					✓		✓	
5	Bengal fox					✓		✓	✓
6	Red fox	✓	✓			✓	✓		
7	Smooth coated otter					✓			
8	Small Indian Mongoose	✓	✓	✓	✓	✓	✓	✓	✓
9	Grey Mongoose	✓	✓	✓	✓	✓	✓	✓	✓
10	Small Indian Civet							✓	
11	Indian Wild boar	✓		✓	✓	✓		✓	✓
12	Hog Deer					✓			✓
13	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 recorded from Indus for All Programme sites is given in Table 10 below.

Table 10 : Conservation status of Large mammals found at four IFAP 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 Mongoose	VU	-	Appendix II
9	Grey Mongoose	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 at the four sites Nara Wetland Complex (10) and Kharochann (10) hold the highest level of diversity of mammals followed by Khyberani (7) Forest. Given the variety of habitats at Nara Wetland Complex (desert, wetland and forest) it is not surprising that this site holds the highest index. Similarly Kharochann supports both terrestrial and marine habitats thus 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 indices do not take into account the diversity across seasons, something that is discussed further in this chapter.

Comparison of Large and Medium sized Mammal Species observed during summer and winter

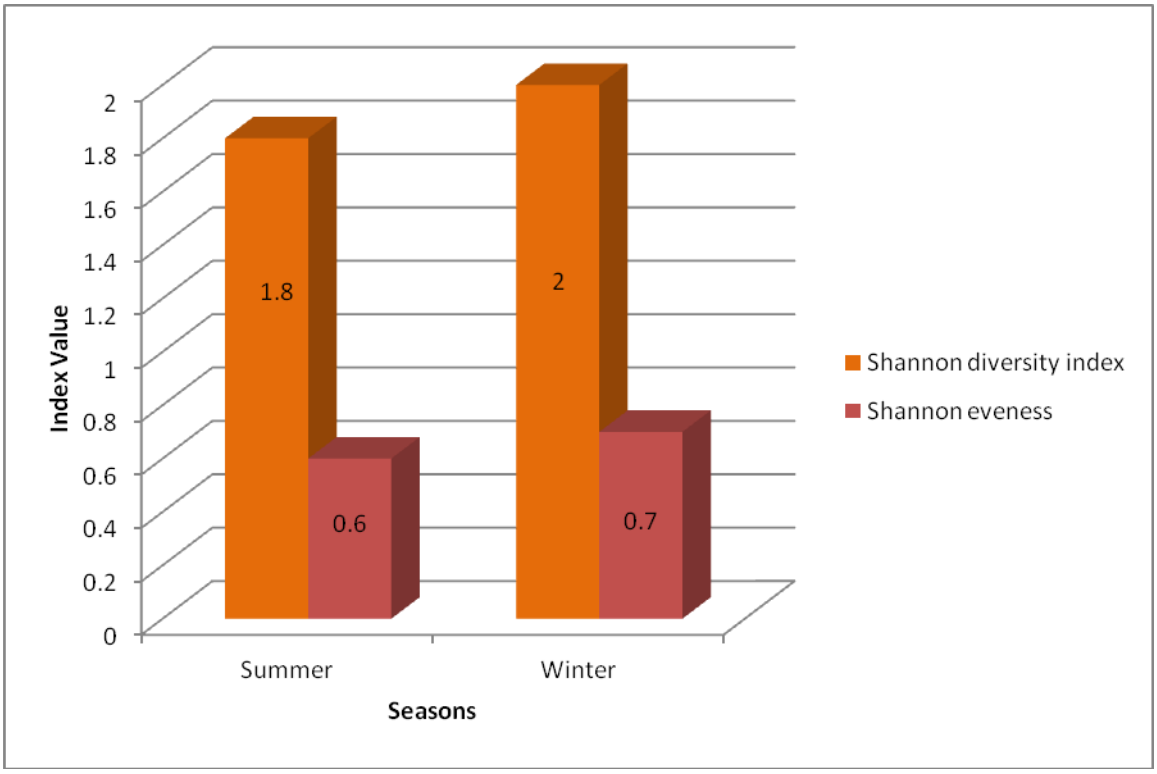
Number of animals recorded during summer and winter surveys are merely rough estimates and not the actual populations. The last column in the following tables showing total animals is not reflecting the total population of different species at different sites. Rather it is just the sum of observed animals observed during summer might be the same counted or observed during winter. Observation records are presented in Table 11 below:

Table 11: Large and Medium sized Mammal Species observed at four IFAP sites during summer and winter Surveys

S. No.	Common Name	Nara			Khyberani			Manchhar			Kharochann		
		W	S	T	W	S	T	W	S	T	W	S	T
1	Asiatic Jackal	4	1	5	5	2	7	2	-	2	3	-	3
2	Jungle Cat	1	0	1	1	-	1	1	-	1	1	-	1
3	Fishing Cat												
4	Desert Cat												
5	Bengal Fox												
6	Red Fox	1	0	1									
7	Smooth-coated Otter												
8	Small Indian Mongoose	5	5	10	2	2	4	1	1	2	3	2	5
9	Grey Mongoose	3	1	4	1	-	1	1	-	1	1	-	1
10	Small Indian Civet												
11	Indian Wild Boar	4	-	4	3	-	3				4	-	4
12	Hog Deer												
13	Indian Pangolin										1	-	1

W = Winter, S = Summer, T = Total

Figure 12- 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 and medium sized 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 at the four sites.

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

threatened

Table 15: 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	-	-	-
No. of species recorded		11	7	6	10
Aggregate threat ranking		2.1	2.0	2.5	2.6

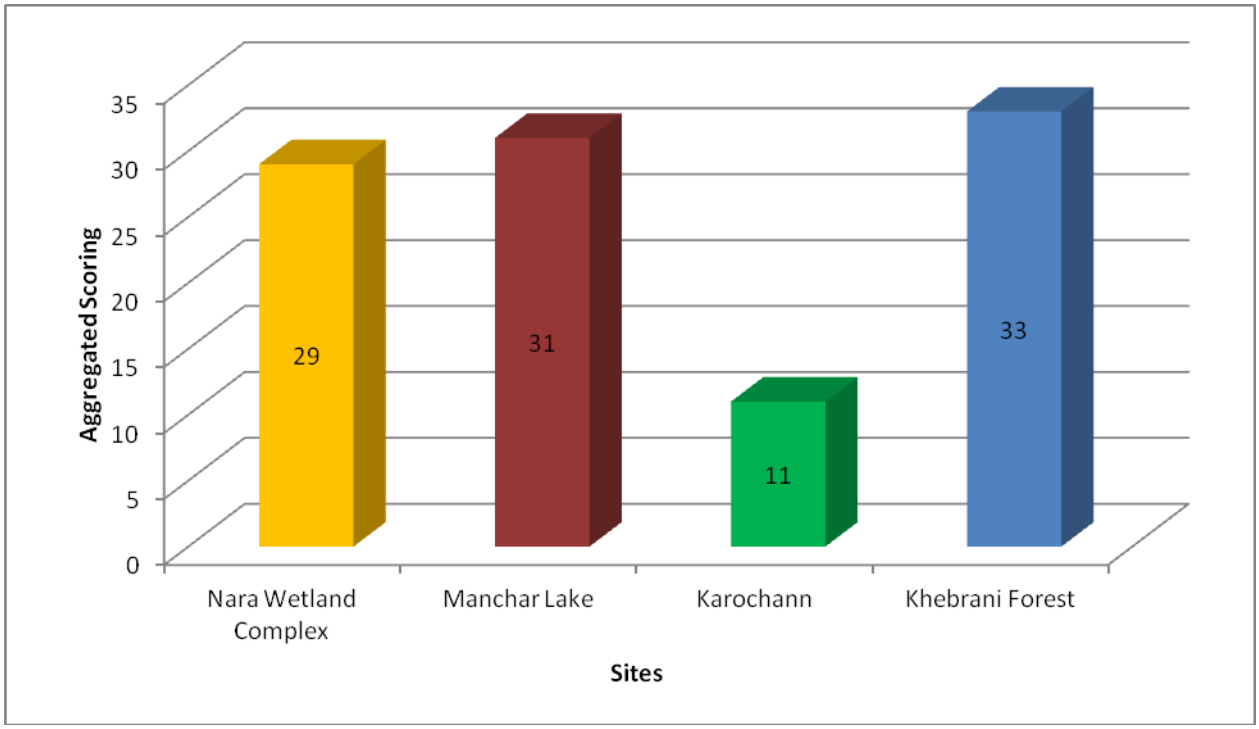
Khyberani Forest and Manchar Lake had the highest averaged disturbance factor against the species that were recorded there. Though this is an arbitrary scoring it does give an indication over the overall threat to large mammals at each site. Figure 22 gives the aggregated score for all sites.

Table 16: 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 fire alarms	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 14: Aggregated score for distribution factors across sites



4.2 Small mammals

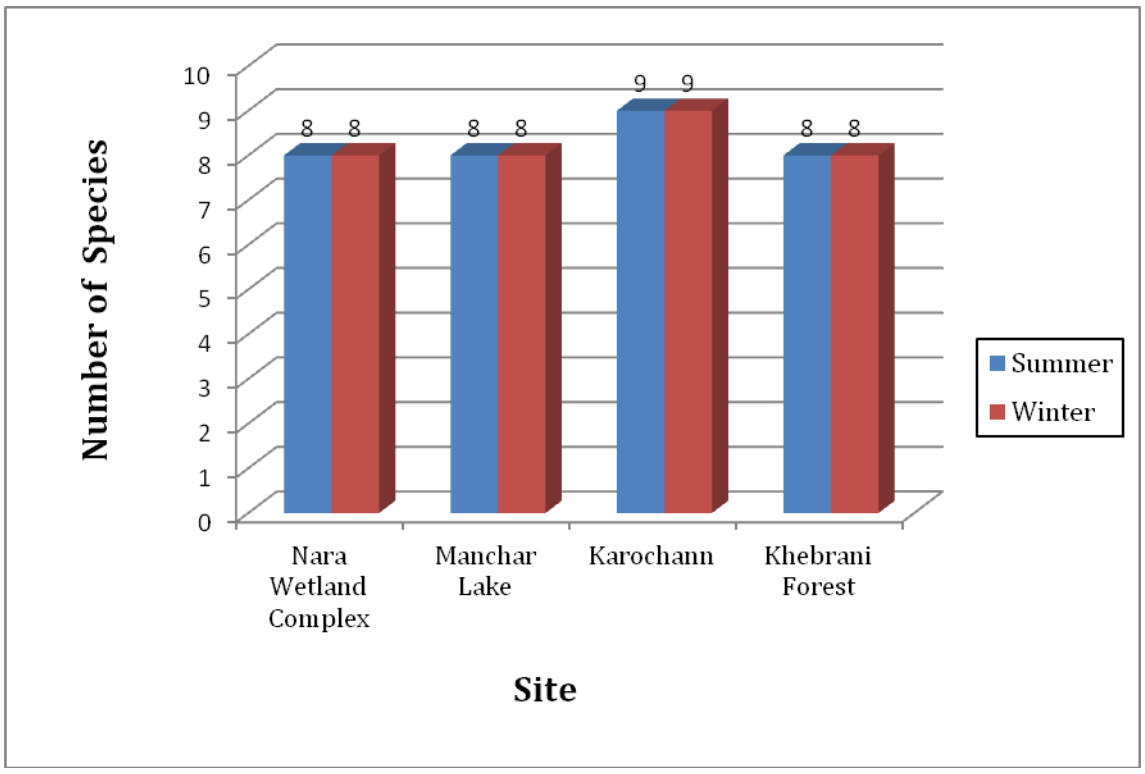
4.2.1Species recorded

Eleven small mammal species were observed at four sites, 8 at Nara Wetland Complex, 8 at Manchar Lake, 9 at Kharochann and 8 at Khyberani Forest. Most of small mammal species are widespread and have been recorded from all 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 restricted to only one site were Mole rat at Kharochann and Indian hedgehog at Khyberani Forest. Table below gives an account of species observed at each side.

Table 17: LIST OF SMALL MAMMAL SPECIES RECORDED FROM EACH SITE

	Common Name	Nara Wetland Complex		Manchar Lake		Karochann		Khyberani 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	+	+	+	+				
	Total	8	8	8	8	9	9	8	8

Figure 15 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 16 and 17 give details of the percentage of species in each site against the main feeding habits.

Figure 16 – Feeding habits of Small mammal species recorded at four IFAP sites (Percent of total)

	Common Name	Kharochann			Khyberani 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 16 –

Feeding habits of Small mammal species recorded at four IFAP sites (Percent of total)

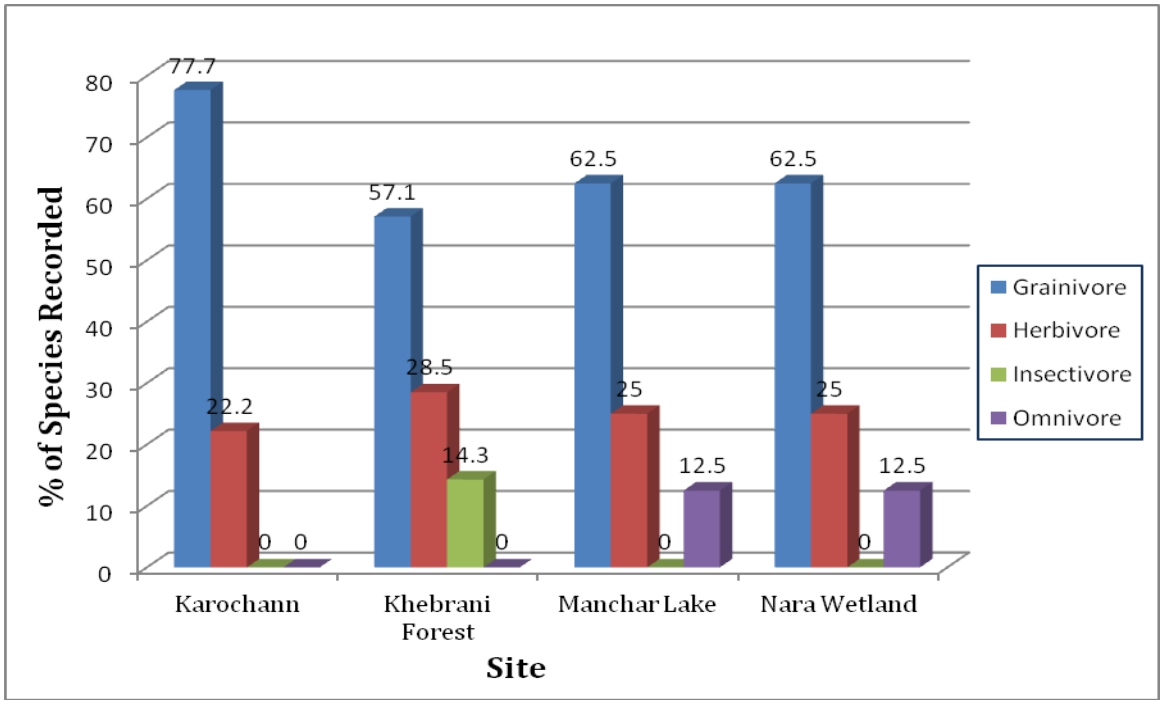
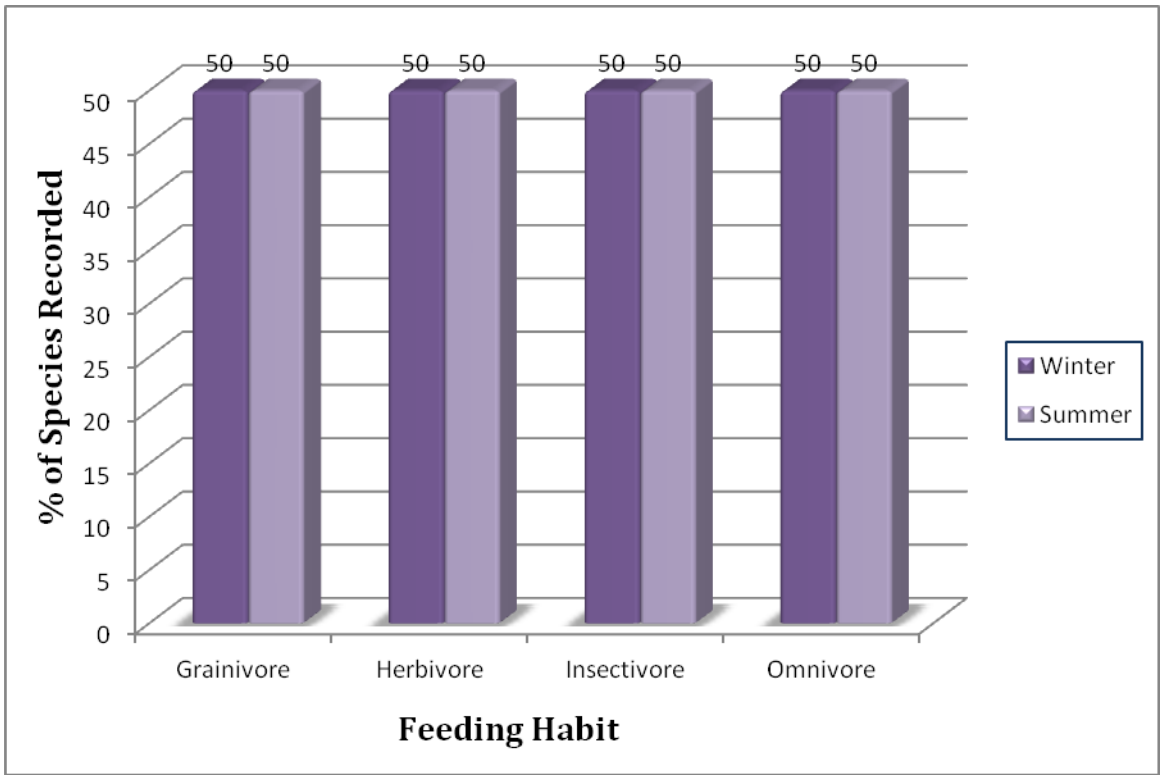


Figure 17 –

Feeding habits of Small mammal species recorded at four IFAP sites during winter and summer (Percent of total)



2.2.3 Habitat

At 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%

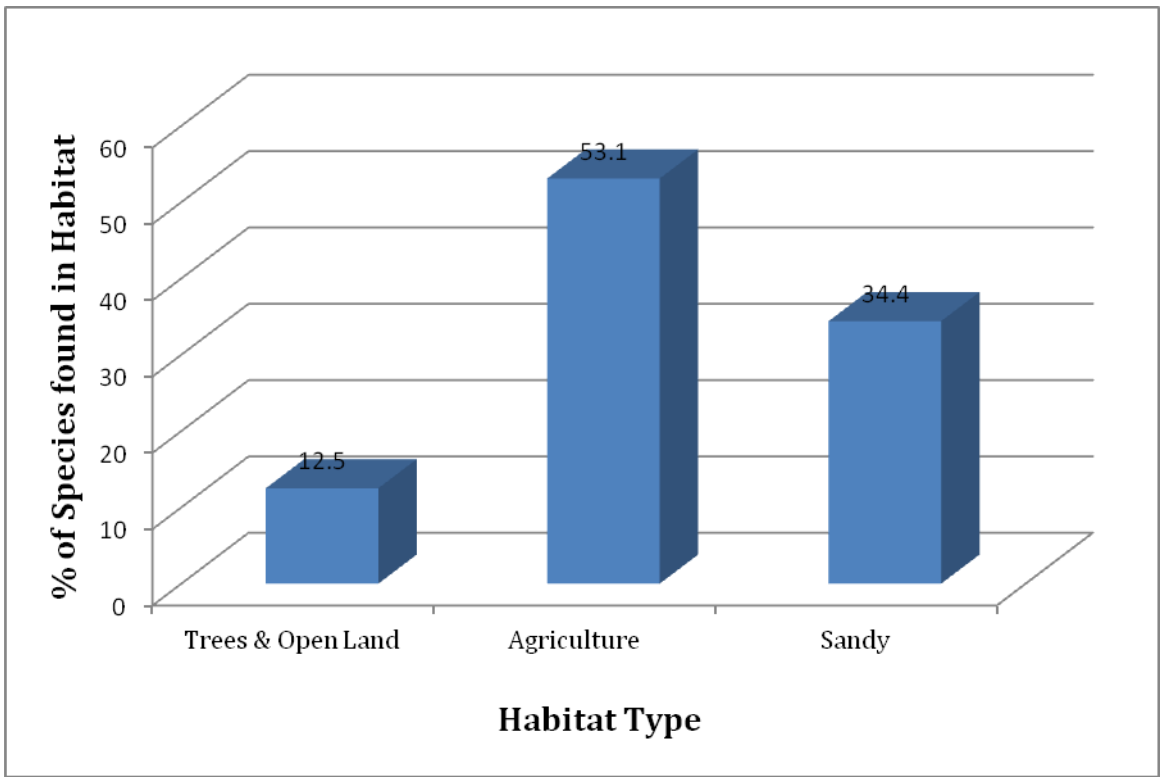


FIGURE 18 – Number of Species observed in different habitat types

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 19 and 20 show the results at all the sites during winter and summer.

Figure 19 –

Status of Small mammal species recorded at four IFAP sites during winter and summer (Percent of total)

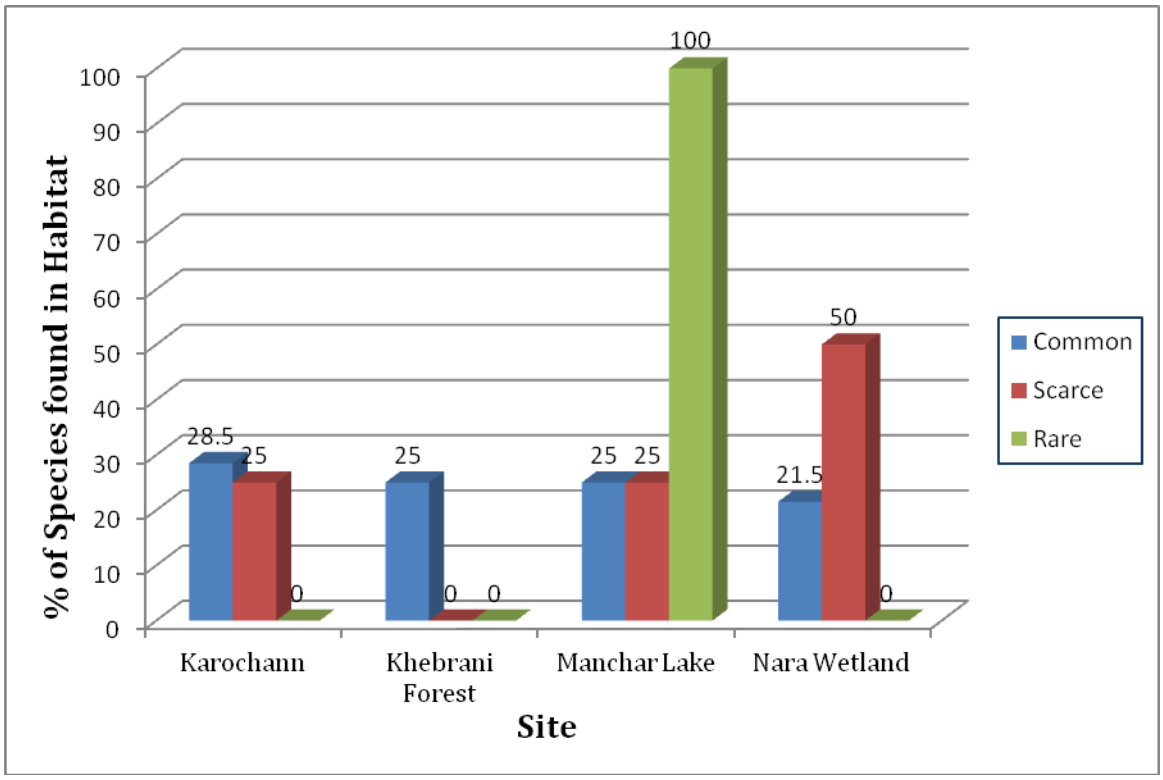
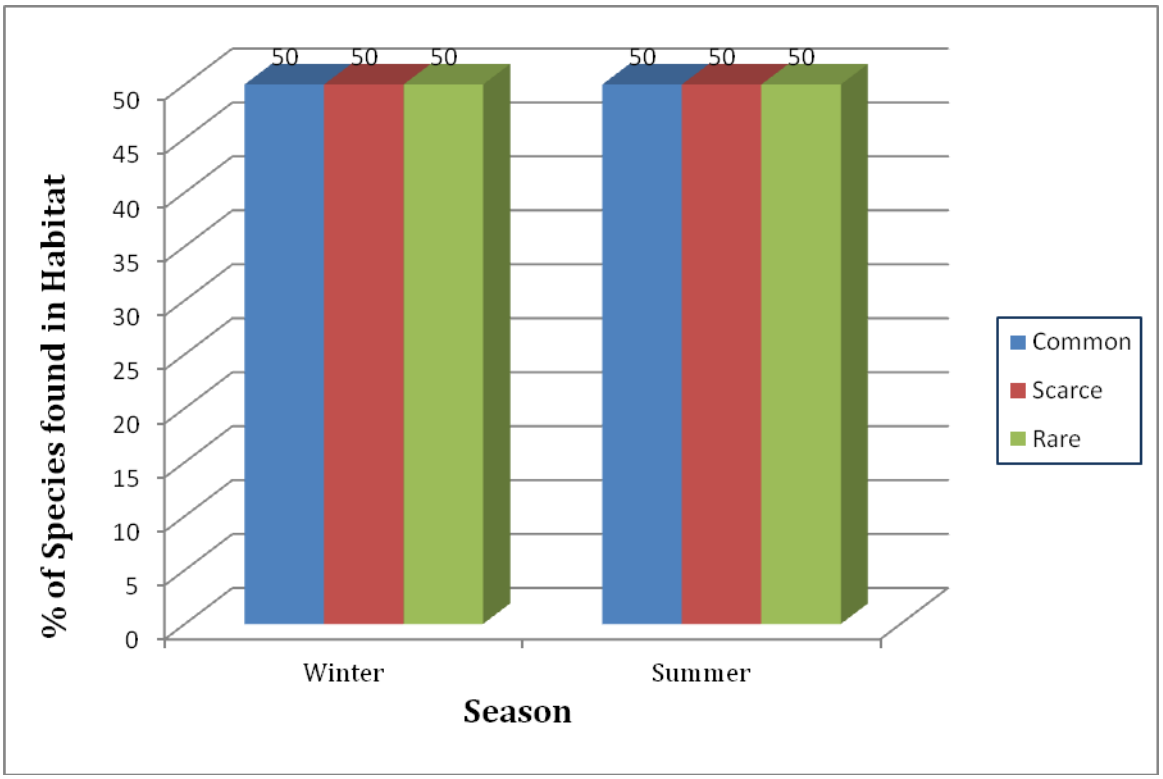


FIGURE 20 – Small mammal species recorded at four IFAP sites during winter and summer (Percent of total)



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 Khyberani forest. As this was a preliminary and brief survey it is possible that some more species may also be present in study areas.

Detailed biological assessment with regard to reptiles and amphibians was made on initially surveyed four IFAP sites *viz.*, Chotiari Reservoir, Kinjhar Lake, Pai Forest and Keti Bunder in 2007 - 2008. During these surveys 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 reptiles are mostly nocturnal therefore survey during night is more appropriate for study of reptiles. However due to some constraints, night surveys could not be undertaken at some 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 a possibility of missing out some species.

Amphibian and reptilian species should be monitored mainly during their activity period 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 may be conducted for a longer period to effectively prepare herpeto-faunal inventory of the area.

4.3.2 Amphibian and Reptilian Species recorded

Thirty seven 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 Khyberani Forest. There was no difference in number of species in winter and summer surveys, except one additional species from Manchar was recorded in summer.

Five species were recorded from all the four sites viz., Indian Garden Lizard, Bengal Monitor, Indian Cobra, Saw scaled Viper and Skittering Frog. . Mugger Crocodile, Brown River Turtle, Spotted Pond Turtle, Glossy bellied Racer and Checkered Keelback were recorded only from Nara Wetland Complex. Similarly, Brilliant Agama, Yellow-headed Rock Agama, Red throat Agama, Punjab Snake-eyed Lacerta and Indus valley Wolf Snake were recorded only from Manchar Lake. Warty Rock Gecko and Bronze Grass Skink were observed at Khyberani Forest only. All species recorded from Kharochann were also recorded from other sites.

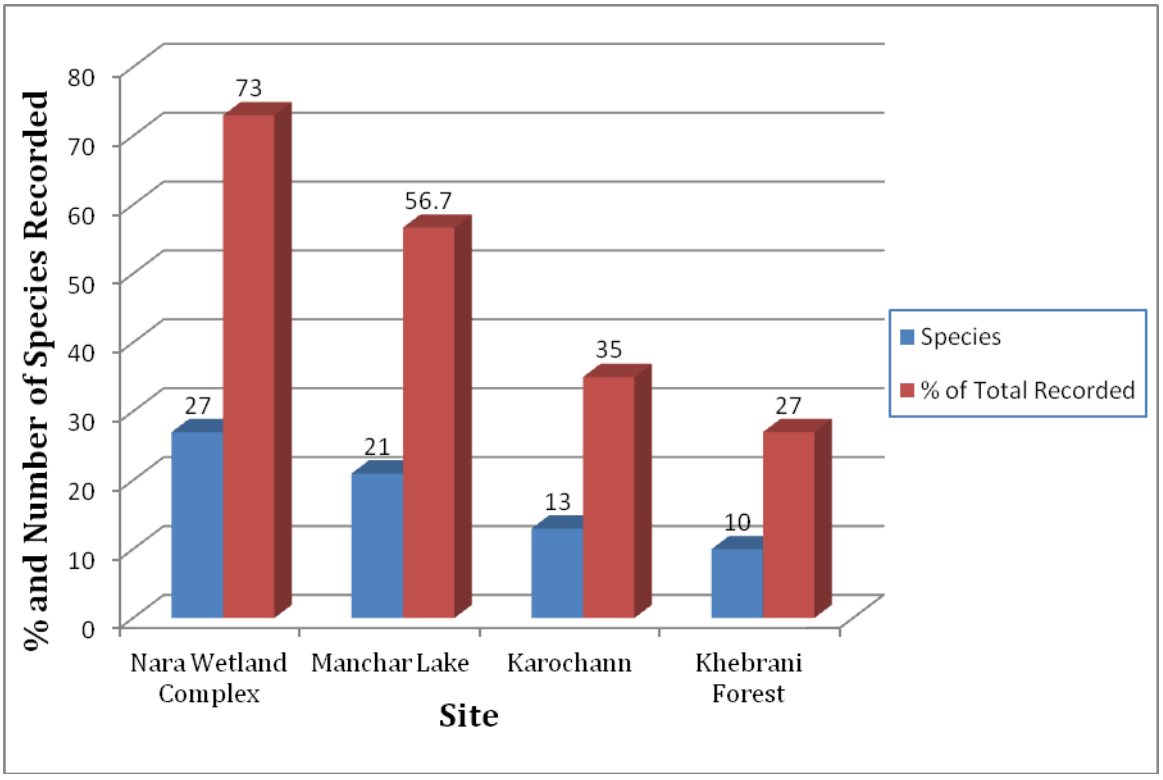
The list of species recorded from each site is given in the following Table:

Table 18 – List of Reptiles and Amphibian Species recorded from four IFAP sites

	Common Name	Nara Wetland Complex		Manchar Lake		Karochann		Khebrani Forest	
		W	S	W	S	W	S	W	S
Reptiles									
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	+	+						
Amphibians									
34	Marbled Toad	+	+	+	+			+	+
35	Bull frog	+	+			+	+	+	+
36	Skittering Frog	+	+	+	+	+	+	+	+
37	Indus valley Toad					+	+		

Figure 21 – Total number and percentage of species 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 presented in Table 19 show that Manchar Lake has the highest number of species followed by Nara Wetland Complex, Kharochann and Khebrani Forest. However the evenness analysis shows that----------

TABLE 19 Amphibian and Reptilian Species Diversity

S. No.	Type of index	Nara Wetland Complex	Manchar Lake	Kharochann	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

How do you interpret the data?

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. Most wetlands have an area of about 200 ha and are 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 was the first record from Sindh province.

4.4.1.2 Manchar 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 Khirthar mountains.

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 Khirthar 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 predominantly 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. Six major creeks in the area are: Chann, Rohra, Ghora, Khichry, Mal and Wari.

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. Kharochann 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 purposes.

4.4.1.3 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 reserved

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 30 families and 11 orders 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 Bird Species recorded

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

Table 20– Total number of bird species recorded at each site

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

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

Table 21: LIST OF BIRD SPECIES RECORDED FROM EACH IFAP SITEs

	Common Name	**Nara Wetland Complex**		**Manchar Lake**		**Kharochann**		**Khyberani 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 of water for Physico-chemical properties and for Microbiological analysis were collected from three sites in Manchhar area. The samples of lake water were collected from Goth Bubak, Zero Point at Goth Muhammad Mallah and from Outlet at Shawan.

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

  The hardness of water ranged between 733.6 mg/l and 931 mg/l; above the prescribed standard of National Standards (WHO) which is less than 500 mg/l. The concentration of Arsenic 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 faecal 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 faecal coliform in freshwater is an indicator of contamination with human and animal excreta.

  The overall study shows that water quality of Manchhar lake has 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 also affect lake water quality.

- **Kharochann**

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

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

  The microbiological analysis of the sample showed the presence of faecal coliform which is harmful for human health. The presence of this bacterium in water may cause water borne diseases like dysentery, gastroenteritis, typhoid fever and hepatitis A. The presence of the bacterium in water indicates a higher risk of pathogens being present in water. The water is microbiologically unfit for human consumption.

- **Nara Wetland Complex**

  The water quality in the area is generally sweet. Total dissolved solids (TDS) ranged between 500 and 800 ppm. There are also some brackish lakes in the area. TDS varied between 10,000 and 28,000 due to low recharge. The ground water quality is dominated by Sulfate, Cl, Ca and 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 brackish lakes.

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

  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 was 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 fecal coliform. The water containing faecal coliform is harmful for human consumption as this may cause water borne diseases. 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 is 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 salt water has greater conductivity. The water was not analysed as per guidelines for agriculture purpose.

- **Kharochann**
  The water analysis results were compared with national standards for drinking water quality; the analysis showed that water quality did not meet the acceptable standard for agriculture. The TDS was not measured.

- **Nara Wetland Complex**

4.5.1.3 Fisheries

Water quality parameters were taken only 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 at three study sites
KHYBERANI FOREST

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 at three study sites

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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