Preliminary Environmental Baseline Study Report,

Keti Bunder, Kinjhar Lake, Chotiari Reservoir and Pai Forest - Sindh

INDUS FOR ALL PROGRAMME

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ACRONYMS

AKPBS	Aga Khan Planning & Building Services
AU	Animal Unit
BDL	Below Detection Limit
BOD	Bio-Chemical Oxygen Demand
CITES	Convention on International Trade in Endangered Species of Fauna & Flora
COD	Chemical Oxygen Demand
DMY	Dry Matter Yield
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMMP	Environmental Management & Monitoring Plan
GIS	Global Information System
GPS	Global Positioning System
HANDS	Health and Nutrition Development Society
HPLC	High Pressure Liquid Chromatography
IDER	Indus Delta Ecoregion
IFAP	Indus for All Programme
IUCN	International Union for Conservation of Natural Resources
I.V.	Importance Value
K.B.	Kalri Baghar
Kg/ha	Kilo grammes per Hectare
LBOD	Left Bank Outfall Drain
NEQs	National Environmental Qualities
NGO	Non Governmental Organisation
PUF	Proper Use Factor
RBOD	Right Bank Outfall Drain
R.C.	Relative Cover
R.D.	Relative Density
R.F.	Relative Frequency
SDR	Summed Dominant Ratio

STDP	Sindh Tourism Development Corporation
TCC	Total Coliforms Count
TFC	Total Faecal Coliforms Count
TFS	Total Faecal Streptococci
TSS	Total Suspended Solids
WHO	World Health Organisation
WWF	World Wide Fund for Nature

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This report is a result of a collaborative effort involving experts from various disciplines and institutions. I sincerely acknowledge their hard work in compilation of valuable information contained in this report. The team included the following;

- Dr. Hafiz-ur-Rehman, Hetrpatologist
- Syed Ali Hasnain, Large Mammals
- Mohammad Rafique, Ichthyologist and Small Mammals
- Jahangeer Durranee, Ornithologist
- Rab Nawaz, Ornithologist
- Ms. Rahat Najam, Limnologist
- Prof. Dr. Surayya Khatoon, Plant Taxonomist
- Mr. Muhammad Imran, Plant Taxonomist
- Dr. Rehmatullah Qureshi, Plant Taxonomist
- Mr. Shakil Khaskheli, Botanist
- Mr. Saad-ul-Islam, Plant Taxonomist
- Mr. Babar Khan, Field Biologist
- My. Mohammad Waseem Khan, Large Mammals

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Dr. Ghulam Akbar
Team Leader

EXECUTIVE SUMMARY

The Indus for All Programme has recently been initiated by WWF – Pakistan with support from the Royal Netherlands Embassy (RNE). The overall purpose of the Indus for All Programme (IFAP) is to initiate implementation of visionary Indus Ecoregion Conservation programme in collaboration with the Government of Sindh, its relevant departments, civil society organization and local communities. The Programme has been envisaged in four of the fifteen prioritized ecosystems of Indus ecoregion *viz* Keti Bunder Mangrove Forest, Kinjhar Freshwater Lake, Chotiari Reservoir and Pai Forest. It aims to work with all relevant stakeholders at field, district, provincial and national levels.

Under Output 1.1.2 of the programme, ecological assessment including detailed documentation and analysis of various natural resources, pressures and options for improving their situation in the selected priority ecosystems is to be carried out during the implementation phase of the programme. In this regard, a field survey was conducted from September 16-25, 2006 in Keti Bunder, Kinjhar, Chotiari and Pai Forest for the preliminary baseline studies regarding flora, fauna, fishes and other environmental parameter.

The baseline studies covered Natural Vegetation Assessment, Small and Large Mammals, Ornithology, Herpetology, Ichthyology and Limnology, particularly focusing on abundance, diversity and species according to their habitat preferences. The studies also identified possible threats to the species and habitats and suggested measures for long term planning and management. The study was conducted by a team of consultants of concerned disciplines. The salients of these findings on each of the four study sites are summarized below.

1. **Keti Bunder** is one of the major towns in Indus Delta that is facing a multitude of environmental degradation and loss of livelihood opportunities for the locals. The Keti Bunder North is a Wildlife Sanctuary harbouring the significant population of migratory and resident waterbirds. This area has great ecological and economic significance because of the mangrove ecosystems it occupies. These ecosystems almost entirely support shrimp fishery that earns 100 million US $ annually. Normally mangrove ecosystems are pristine and do not require much management unless ecological processes are disrupted. In spite of overwhelming importance of mangroves, little attention has been paid to their management in Pakistan. Mangroves are disappearing at an alarming rate and main causes of such rapid decline are rooted among unawareness among policy makers, authorities and public at large.

The Flora of Keti Bunder was assessed and 39 species belonging to 32 genera and 19 families are identified. The major plant families which contributed in the formation of vegetation in the area are Chenopodiaceae (17.95%) and Poaceae (12.82%) followed by Amaranthaceae (7.69%), Aizoaceae (7.69%), Papilionaceae (5.13%), Boraginaceae (5.13%), Tiliaceae (5.13%) and Zygophyllaceae (5.13%).

The mammalian fauna of Keti Bunder includes both aquatic and terrestrial mammals. Five species of aquatic mammals (dolphins and porpoise) and three species of large mammals and fifteen species of small mammals have been recorded.

Among birds, a total of 69 species were observed which include 25 resident species and 44 migratory species. Besides, 21 species of reptiles and 2 species of amphibians have been recorded. Among fish, 63 species of fin fish and 24 species of shell fish were recorded.

The limnological study at Keti Bunder shows normal ranges of water quality parameters except the total suspended solids (TSS) which is higher than the standard value. Similarly in the case of oil and grease the higher value was found. Phytoplankton community is mainly composed of 8 genera, of which diatoms (*Chaetoceros sp., Coscinodiscus sp., Rhizosolenia sp.* and some concentric diatom *sp.*) formed the dominant group followed by dinoflagellates (*Goniaulax, Ceratium, Dinophysis*) and tintinids. 20 groups of zooplankton community were found of which copepod, cypris larvae of barnacles, cladocerans, decapod and gastropod larvae were the conspicuous members of the family. Copepods dominated and formed the most important group of zooplanktons.

Keti Bunder is facing acute scarcity of fresh water and the ecological impact of seawater intrusion is predominantly visible. This intrusion is causing higher salinity of the soil and loss of inland vegetation. In addition to this, there is heavy cutting of mangrove forest and extensive camel grazing. Camels were observed in the reserve forests and water was no obstacle for them when it comes to grazing on mangrove plants. A few of the other social and environmental problems in the area include pollution, unsustainable fishing practices like use of harmful fishing nets, birds shooting and trapping, change in land use practices, absence of fish landing station (jetty), lack of education and awareness of natural resources and inadequate of alternate livelihood opportunities.

2. **Kinjhar Lake**, also known as Kalri Lake is one of the largest lakes in Pakistan. It has length of about 24 km, width 6 km and capacity of 0.53 million acre feet. It is located at a distance of about 122 km from Karachi and 86 km from Hyderabad. The lake was created in 1930s from the two smaller lakes Kinjhar and Kalri by the construction of a dam at Chilya and a 12 km embankment on the eastern side. Indus provides Kinjhar, the required water through Kalri Baghar (KB) Feeder. KB Feeder starts from Kotri Barrage. Since the area is arid and receives less than 200 mm annual rainfall, hence Indus is the only source of water for this lake.

The vegetation assessment of Kinjhar was done and 139 species belonging to 104 genera and 40 families have been identified. The major plant families which contributed in the formation of vegetation in the area are Poaceae (15.12%), Papilionaceae (7.19%), Compositae (5.04%), Amaranthaceae (4.32%), Boraginaceae (4.32%), Chenopodiaceae (4.32%), Capparidaceae (3.6%), Euphorbiaceae (3.6%), Tiliaceae (3.6%) and Solanaceae (3.6%).

In vertebrate fauna, 3 species of large mammals belonging to 2 Orders and 4 Families have been recorded. Further, 21 species of small mammals have also been recorded. The birds belonging to 91 species including 58 migratory and 33 residents were recorded. The reptilian fauna comprises of 29 species that were recorded. The fish fauna consists of 48 species.

The limnological study at Kinjhar Lake showed water quality parameters values in normal ranges but the higher values obtained for total suspended solids, biochemical oxygen demand and chemical oxygen demand and for oil & grease. The higher numbers of total coliforms ($\geq$ 2400), total faecal coliform ($\geq$ 2400) and total faecal streptococci (< 3) were found in the water of Kinjhar Lake, the water is not fit for human consumption of drinking. The commercially used pesticides analysis depicted as negative for malathione, cypermetherine, aldrin and dialdrin. Among phytoplanktons comprised of major groups of chlorophyta, cyanophyta and euglenophyta. Among which 17 species belonging to phylum cyanophyta (cyanobacteria) 4 species identified from the order nostocales. These species are of genus a*nabaena*, *merismopedia* and *microcystis* and *oscillatoria* commonly referred as toxic. Beside these 7 species of phylum chlorophyta and 1 species belonging to euglenophyta has been recorded. Two phyla of zooplanktons identified from the samples which were rotifera and arthopoda. Among which the cladocera was dominant followed by cyclopoida. There was 1 genera of rotifera recorded in the samples whereas 9 genera recorded from arthopoda. Overall 12 species recorded from the samples. 2 species of mollusks (dead shells) identified from the muddy and sedimentary samples.

This site has probably suffered the most from anthropogenic activities including over-exploitation of the natural resources. The major threats observed to this water body included ill - planned tourism, pollution, habitat degradation, livestock grazing, and introduction of exotic fish and plants species and establishment of the poultry and livestock farms at eastern bank of the lake. Eutrophication has also been observed in parts of the lake.

It is probably the site with the most exploitative fishing practices out of all four sites. Even though the local fisheries department stocks the lake, it is doubted that it is in numbers that can contribute to the local pollution and the favored stocking species is *Talapia,* an exotic species that caused incalculable damage to the aqua diversity of the country.

Settlements on the bank of the lake are also becoming a major problem. Most are illegal but have established large villages right on the bank of the lake whereas there is a buffer zone that is supposed to be followed as part of the nomination of a wildlife sanctuary.

3. **Chotiari Reservoir** lies on the western flanks of Anchar Thar desert at about 30 – 35 km north east of Sanghar town. The reservoir occupies an area of about 18,000 ha and has water storage capacity of 0.75 MAF flooding an area of approx. 160 sq. km. Chotiari is created in a natural depression that exists along the left bank of the Nara canal. The depression is bounded by sand hills towards north, east and south east, while towards west and south lies the Nara canal. The whole area has undergone a drastic change in topography and habitat due to the dam that has been built. However, many of the canals and old bunds remain rich in wildlife. There is increasing pressure on the natural resources and cutting of trees and removal of floral species for the production of local products is quite rampant in the area.

The flora recorded during the base line survey includes 115 species of plants belonging to 83 genera and 40 families. The major plant families which contributed in the formation of vegetation in the area are Poaceae (19.13%), Papilionaceae (10.43%), Amaranthaceae (5.22%), Aizoaceae (3.48%), Mimosaceae (3.48%), Capparidaceae (5.22%), Solanaceae (5.22%) and Zygophyllaceae (3.48%).
The fauna includes 10 species of large mammals belonging to 2 Orders and 6 Families and 21 species of Small mammals, 67 species of birds (33 migrants and 34 residents), 32 species of Reptiles, 2 species of Amphibians and 45 species of fish. Limnological

study indicates the normal ranges for water quality parameters at Chotiari Reservoir except values for total suspended solids, biochemical oxygen demand and for chemical oxygen demand which are higher. Similarly the higher value obtained for oil and grease. There were negative results found for commercially used pesticide which were malathione, cypermetherine, aldrin and dialdrin. But the further analyses were done and positive results were obtained for the following pesticide which was Acetempride. The phytoplankton community is composed of 20 species belonging to cynophyta, 13 species belonging to phylum bacillariophyta (diatoms), 9 species from chlorophyta, 4 species from euglenophyta, 3 species from xanthophyta and 1 species from pyrrophyta recorded from Chotiari reservoir. 2 phyla of zooplanktons identified from the samples which were Rotifera and Arthropoda. Altogether 11 species identified from the samples from which 3 belongs to order ploima, 2 belongs to order copepoda, 1 from calanoida and 5 from cladocera. Macro invertebrate belongs to phylum Mollusca. 1 individual of *Lymnaea stagnails* belong to class Gastropoda was also found.

The biggest impact on the habitat was found because of the construction of reservoir. Few habitats were found quite monotonous in terms of flora and fauna contained therein. Game birds and mammals are under increasing pressure from uncontrolled hunting or trapping, except in the privately owned reserves where controlled hunting is practiced. The Hog deer which is an indicator species has now vanished from the wild and is available only in the private reserves in the area.

4. **Pai Forest** is an irrigated plantation having an area of 4777 ac (1933 ha). It is located at a distance of about 5 km from Sakrand town in Nawabshah district. The areas of Deh Marvi is located in the north – west of the forest, Deh Sakrand in the north – east, Deh Tali in South, Deh Morio Lakho in south – west and Deh Batho in the east. The area is divided into 139 small compartments of 40 acres each. In 27 compartments, out of 139, small patches (about 8 acres) are reserved for cultivation of cotton, wheat and mustard.

Due to non friendly environmental planting schemes, such as the social forestry under which Eucalyptus was introduced has caused the declination of habitat richness ultimately causing a loss of biodiversity in the area. Scarcity of water, poor management and severe lopping and cutting of trees are all factors rendering the forest barren. A lot of the trees are infested with termites and grazing is rampant in the area. It was discussed during and after the surveys that the area maybe removed from the Indus For all Programme and replaced with a more suitable site representative of riverine forest. The forest was abode for Hog deer but its population has declined alarmingly due to hunting pressure. It was estimated during the present base line survey that at present there are maximum of 6 pairs of hog deer and in total 18 animals only. The vegetation assessment carried out at Pai Forest recorded 62 plant species belonging to 49 genera and 29 families. The faunal assessment include occurrence of 4 species of large mammals belonging to 2 Orders and 4 Families, 7 species of birds, 22 species of reptiles and one species of amphibian.

SECTION 1

INTRODUCTION

1.1 BACKGROUND OF STUDY SITES

WWF – Pakistan has initiated Indus Eco-region Programme, which is a 50 year vision. A total of 15 ecosystems have been prioritized within this eco-region. Indus for All Programme has been initiated to start implementation of the visionary Indus Eco-region Conservation Programme. Indus for All Programme is being implemented in four out of fifteen prioritized ecosystems *i.e.* Keti Bunder, Kinjhar Lake, Pai Forest and Chotiari Reservoir. Implementation at four sites has started from July 2006 and would continue till March 2012. 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.

At the inception phase of the programme, WWF – Pakistan planned to conduct the situation analysis and baseline study of natural resources/biodiversity in the four programme sites of Indus for All. The present report is based on the study conducted from 16 - 22 September 2006 at four selected sites. A brief description of the each site is given below:

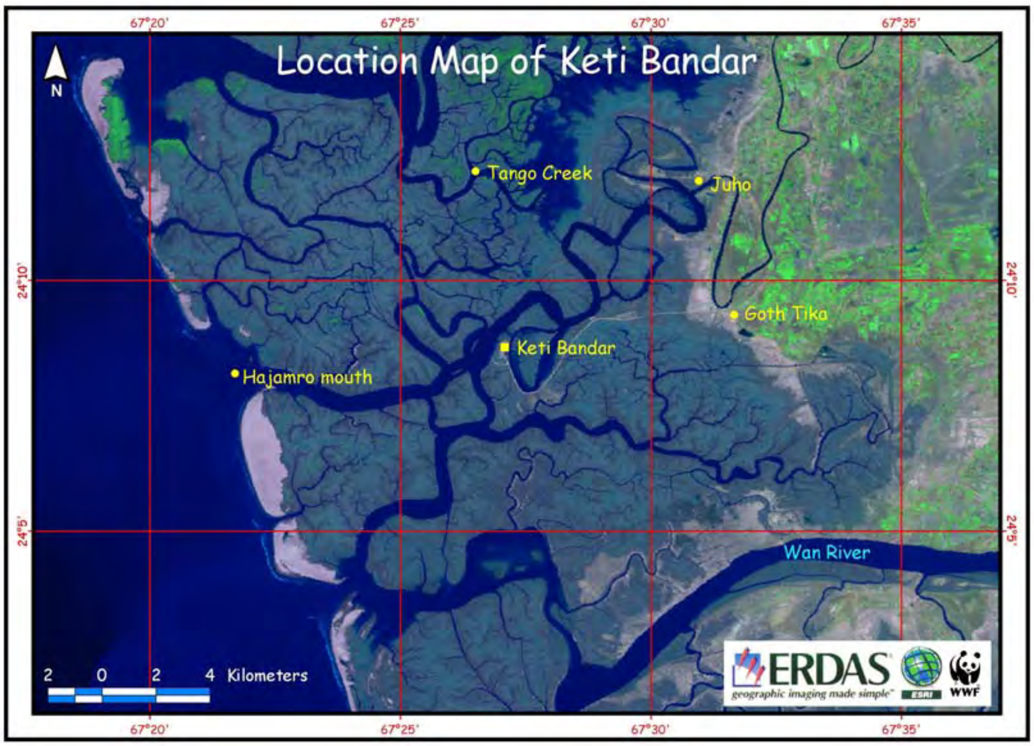
1.1.1 Keti Bunder:

Keti Bunder**,** Taluka (Tehsil) of Thatta district of Sindh province is situated at a distance of about 200 km SE of Karachi. It is located in Indus Delta experiencing warm monsoon climatic regime. Mild winters extend from November to February while summer season extends from March to October. Most of the annual precipitation takes place during monsoon which is erratic in distribution. Mean annual rainfall is 220 mm. January is the cooler month with minimum temperature of 9.5 ^{o}C while in June – July minimum and maximum temperatures range from 23 ^{o}C – 26 ^{o}C and from 30 ^{o}C - 36 ^{o}C, respectively. Humidity is generally higher in the morning than in the afternoon. It also varies from place to place depending upon the proximity to the sea. Wind is another important feature of coastal zone. It is variable and is faster during summer (7.4 to 20.5 km/h) than winter (Qureshi 1985).

Keti Bunder consists of a total of 42 dehs (cluster of villages) that spread over a total area of 60,969 hectare. It is believed that the sea has engulfed 28 dehs and the total affected area in Keti Bunder Taluka is around 46,137 hectare (WWF 2004). Hoekstra *et al.* (1997) mentioned that Keti Bunder Tehsil includes a total of 19 Dehs and 29 villages while total human population is around 12000.

Historically, the location of Keti Bunder town has changed thrice during the past 70 years due to progressive intrusion of the sea. There are four major creeks in the area viz. Chann, Hajamro, Khobar and Kangri with innumerable small creeks.

Human population of the Keti Bunder town and adjacent creeks is about 12,000. Majority of them are fishermen and belong to Baloch, Jat, Memon, Shiekh, Dabla, Solangi, Syed and Gug tribes. Traditionally agriculture, livestock and fishing were three major sources of livelihood of the community of this area. For sweet water needed for drinking and farming, Keti Bunder and other coastal region depend entirely on Indus River and its distributaries. Before construction of upstream barrages, river water used to reach the tail end during low tides round the year. However, upstream dams and barrages have considerably reduced the river flow to the extent that Kharo Chan and Shah Bunder areas that had good agrarian economy in the past and produced plenty of high quality red rice, are now facing acute water shortage. During aabkalani (flood season), water is stored in ponds for subsequent human and livestock use. The agriculture has now deteriorated due to water logging and salinity of lands. During off season (May to August), local people were dependent on agriculture practices in the past and fish during other months of the year (Qureshi 1985). Scarcity of fresh water in the area from the Indus and seawater intrusion into the land has been degrading the area. Currently, dominant sources of livelihood include fishing 90%, agriculture and livestock rearing 8% and services in various sectors 2%. The women of the area have more freedom as compared to other agricultural and pastoral communities; however, they are not involved in livelihood activities and are responsible mainly for household chores and the livestock. Almost 90% population of the area is illiterate. People are living below the poverty line and thus their dependence on natural resource has increased.



Communities in and around main creeks in Keti Bunder area have cattle, buffaloes and camels. Camels have popularly supposed to have aversion to water and not to thrive in damp areas but in Delta region, camels feed on mangrove foliage, wading in the mud and swim in the creeks (Hoekstra *et al.* 1997). Majority of the camels are kept by Faqirani Jat community in Keti Bunder. During monsoon season, camels of inland communities are also grazed in creeks area. According to one estimate there are about 5000 camels in mangrove areas (Hoekstra *et al.* 1997), however, Qureshi (1985) reported a total of 16,000 in the entire Delta region. Correct estimates are still required particularly in Creeks adjacent to Keti Bunder where lot of camel grazing is obvious. Camels are generally kept to raise cash income through sale of one year old males. These animals are also kept for sacrifices on Eid festival. Milking of camels is generally for family consumption. Camels generally feed on *Avicennia marina* browse, however, in Kharochan area; they also graze on grasses growing on mud flats. In mangrove area, camels are not herded and they keep on grazing free. Drinking water to camels is provided through boats. Camels stay permanently in mangroves year-round except for two months (June – July) when they are moved to some high lying areas near the sea for mating. Some of the herders reported to move camels to an open area during June/July due to presence of biting flies in mangroves (Hoekstra *et al.*1997)

Two systems of mangrove management; formal and non-formal, have been described by the earlier. In the formal system Forest Department issues permits to local communities in 'Protected Forests' in exercise of their customary rights for collection of wood and livestock grazing against a nominal fee. However, neither such fee has been collected for the last 15 years nor access been denied to any body except replanted areas Hoekstra *et al.* (1997). In non-formal system of management, Jat community being more influential in exploitation of vegetation and fish resources of mangrove ecosystem have sub divided the mangrove areas of Keti Bunder among villagers. An island allocated to a particular village is permanently utilized by that village for grazing camels. When such islands become devoid of vegetation due to continuous grazing, they are allocated another island.

Afforesttaion of *Rhizophora sp.* by Sindh Forest Department in Chan Creek.

State of Biodiversity:

- **Natural Vegetation:** Keti Bunder Mangrove forests fall in northern block of management of Sindh Forest Department. They fall under the category of "Protected Forests" vide West Pakistan Government Notification No. S.O.A. (X) F&A/581X-(32) dated August 29, 1958 and the land, water lakes and dhoras in Keti Bunder falling under the jurisdiction of this notification are regarded as Wildlife Sanctuary vide Government of Sindh Wildlife & Forest Department Notification No. WL&FT(DCF-GEN-269).77 dated September 25, 1977.

  In Keti Bunder, mangroves cover an area of 40874 ha out of which 14733 ha area falls under dense mangroves while remaining area constitutes normal and sparse vegetation Qureshi (1985). Dense forests are found in narrow stretches or in blocks along creeks with profuse growth of *Avicennia marina* locally known as Timer. Qureshi (1985) mentioned that eight species of mangroves have been reported to occur in the area but four species have been lost from Indus Delta including Keti Bunder during the past 70 years. Of the remaining species, only *Avicennia marina* constitutes major mangrove spp proportion *i.e*., 95% on the islands of the creeks while others such as *Rhizophora mucronata, Ceriops tagal* and *Aegiceras corniculatum* have only 5% spread on the islands of the creeks. The locals use mangrove trees for fodder and fuel wood, camel browsing and hut making. Mangroves are the breeding ground for variety of fish, shrimps, crabs and other invertebrates. They are also of great significance as a source of nutrients for fisheries. Hence, the livelihood of the community is correlated with the health of mangrove and is important to the local and national economy.

A fisherman family in Chan Creek

- **Fisheries:** Fishing is the main livelihood resource of the community. Fish, shrimps and crabs are harvested on regularly basis. Besides, providing valuable export earnings to the country, it is the primary source of livelihood of the population. There has been reduction in fish catch in recent years. One of the reasons is the unsustainable fishing practices adopted by the community. Details of fish species found in the area is provided separately in Ichthyology report.

- **Wildlife:** Keti Bunder North and South is a Wildlife Sanctuary, mainly for the water birds. About 50,000 birds in a migratory season have been recorded from this area in the past. Now the population has declined enormously. The migratory birds include pelicans, egrets, herons, waders, raptors *etc.* Among mammals, jackals are common. In reptiles, cobra, vipers, sea snakes and lizards are common.

- **Agriculture:** Although agricultural practices are not very common, yet vegetable, betel leaf, sugarcane, wheat, fruits (chiku, banana, mango, water melon) are grown in the inland area of Keti Bunder taulka.

1. 1. 2 Kinjhar (Kalri) Lake:

Kinjhar Lake (also known as Kalri Lake) is situated at a distance of about 20 km North and North – East of Thatta town. It is a freshwater lake having about 24 km length and about 6 km width with total area of about 14000 ha. The maximum depth of the lake is 8m. The lake is a wildlife sanctuary and a Ramsar site (wetland of international importance). Kinjhar Lake is set in stony desert, which is composed of alternating layers limestone and sandstone. The lake is fed by the Kalri Bagar feeder canal, which enters at the northwest corners, and by many small seasonal streams entering on the western and northern shores. The only outlet is through the Jam branch canal at the southeast corner of the lake (Anon 2006).

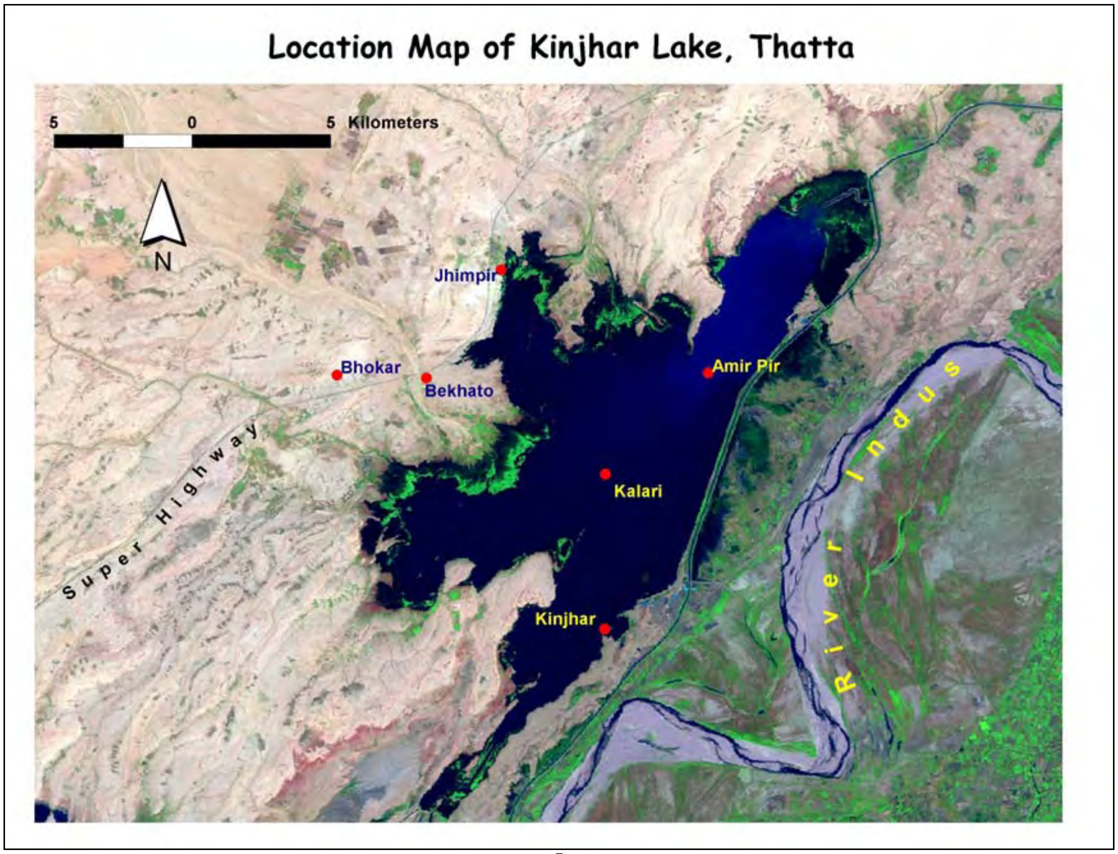
Twelve large villages and about twenty small villages are present all around the lake which fall in four Union Councils viz: Sonda, Oongar, Jhimpir and Chatto Chan of Tehsil and District Thatta. Sonahri, Chill, Ghandri, Chakro, Moldi, Dolatpur, Chilliya, Khambo, and Hilllaya are the major villages. Jhimpir town is also situated on the northern bank of the lake. Before partition, it was surrounded by a population of about 40, 000 fisher men living in the villages mentioned above. However, with the construction of link canal and gradual shortage of water the population of fishermen communities started declining as evident from the table given below (Anon 2006).

Table1: Comparison of Fishermen population and Fish Production

Year	Population	Fish Production (Metric Tons)	No. of Boats
1988-89	**24355**	**58000**	**2200**
1998-99	**11900**	**27000**	**1710**
2005-06	**10320**	**15650**	**820**

Source: KFWS 2006.

About 50,000 people are dependent on the lake. There are four fish-landing centres at the Lake. *Viz.,* Khumbo, Chilya, Sonheri and Jhimpir. Total 800 fishing crafts are operating in the area. The fishers have their own fishing territories and the local community defined them properly.



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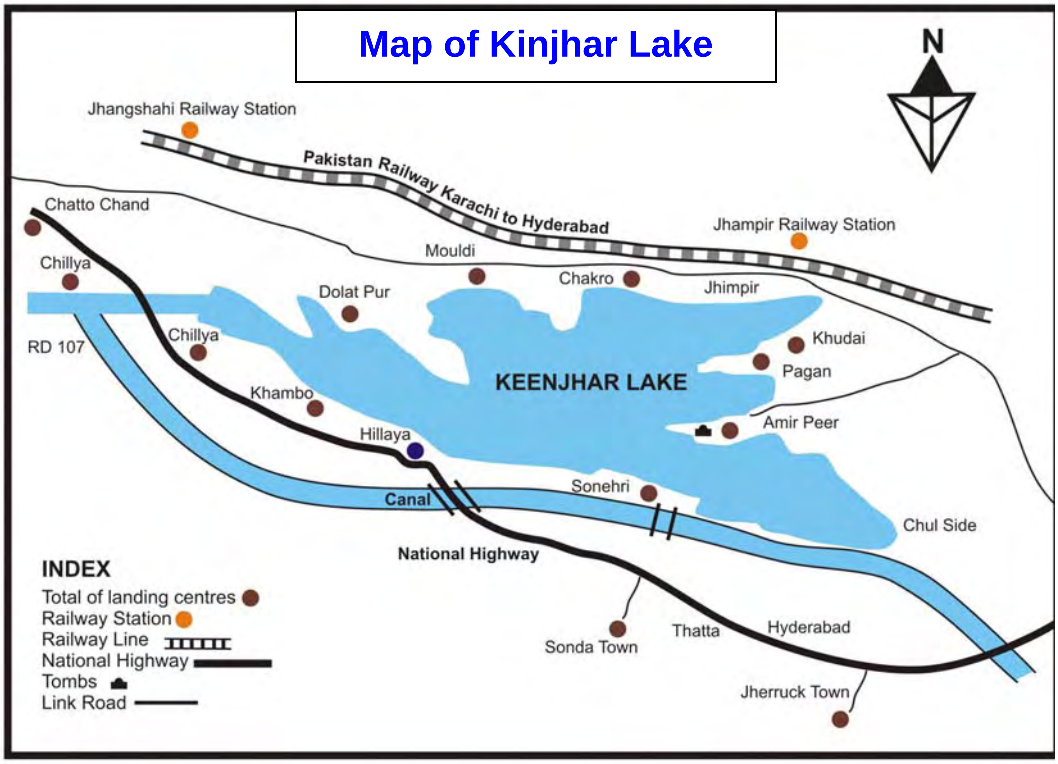
Source: Anon, 2006

For example, the people form the Sonheri village has their own fishing grounds and they never fished in the territories of the Jhimpir areas (Anon 2006).

The main casts/ tribes present are Palari, Shora, Kapai, Gandara, Hilaya, Turk, Katiyar, Khaskheli and Sarki *etc.* The major occupation of the community is fishing and agriculture. People belonging to Palari, Shora, Hilaya and Turk tribes are involved in agriculture around the Lake. Pesticides are widely used in the cultivated area. People have the livestock especially buffaloes, goats, cows *etc.* and they graze them in the buffer zone and around the lake. Other casts are involved in fishing and commonly known as Mir Bahar. The fishing practices of the local communities are generally sustainable. The locals hardly use small mesh size nets to catch the fish. The permanent circular nets placed in the lake locally known, as “Gol Jal” is also sustainable way of fishing.



Source: Anon, 2006

The level of education is low. Twelve primary schools for boys and one high school for boys are present in the area. Health and Nutrition Development Society – HANDS, has also established a community school in one of the villages in collaboration with Gandhara Welfare Association. However, for girls' education the priority has not been given therefore the illiteracy rate among the women is near to 99%.

A sail boat in Kinjhar Lake

The civil dispensaries are present in the four Union councils of the area but due to weak monitoring by the Health department they are not working properly. Generally people suffered from malaria and gastrointestinal diseases.

Due to decline in fisheries some people are also involved in the mining of stones from the nearby stony hills.

Huts of Tourism Development Corporation at Kinjhar lake

Some communities are also earning income from the local tourists coming from Karachi Hyderabad and Thatta for recreational purpose. They have the speedboats and they usually charge Rs. 150 to Rs. 600 based on the time and trip. These boats do not have any safety gears on them, therefore lots of accidents have been occurring in the past and many people lost their lives.

Sindh Tourism Development Corporation has developed a Tourist Center there with Air-conditioned Lodges and visitor's facility. The facility has been developed in a stretch of about 2 km towards eastern side of the Lake and they charge an entrance fee from vehicles and/or visitors into this area.

Fish Resource in Kinjhar is under severe Threat

Irrigation department has a small set up and have a rest house. Towards southwestern side of the lake the Karachi Water Sewerage Board has its own set up to regulate the out let of the Lake. Pakistan Army has also established a rest house on the eastern side of the lake.

Fisheries Department is not actively involved. They are in the process of establishing a small permanent set up on the lake. They have a large set up in Chilya, which is about 10 km away from here.

State of Biodiversity:

Kinjhar Lake is known as freshwater lake and its main source is from Indus River, however, some proportion of water is contributed from the run off from the adjacent hills and torrents. The local villagers residing around the Lake are using water for their daily consumption.

Fauna: Kinjhar Lake is rich in fish fauna. It includes *Ambassis nana*, *Badis spp. Puntius sarana, Puntius ticto, Catla catla, Channa spp. Cirrhinus mrigala, Ctenopharyngodon idellus, Gadusia chapra, Glossogobius spp. Labeo rohita, Labeo gonius, Notopterus notopterus, Rasbora rasbora, etc.* The livelihood of the local communities mainly depends on these resources. There has been reduction in the fish stock due to overexploitation.

Kinjhar Lake is an important breeding and wintering area for a wide variety of terrestrial and migratory birds. About 65 species of waterfowl have been recorded. About 0.1 million migratory birds used to visit this lake during winter, though their number has declined in recent years. Breeding birds include Night heron, Cotton teal, Pheasant tailed Jacana, Purple moorhen, besides some passerines. The Cotton Teal has disappeared in the recent years and have not been seen on

Both terrestrial and migratory birds inhabit Kinjhar Lake the lake for few years. Mammals include Jackals, Fox, Porcupine, Mongoose and Rodents. Pangolin is also recorded. Among reptiles snakes like cobra and saw scaled viper is common. Monitor lizards, spiny tailed lizard are also distributed here.

Flora: Natural terrestrial vegetation of Kinjhar Lake includes a wide variety of plant families. During recent survey 136 species belonging to 104 genera and 41 families are identified. The major plant families which contributed in the formation of vegetation in the area are Poaceae (10.71%) followed by Amaranthaceae (8.93%), Aizoaceae (7.14%) and Tiliaceae (7.14%). A small patch of mangrove trees of *Avicennia marina* also exists and used by the locals as fodder for the camels. These trees have been severally lopped recently. Timber producing species such as Babul (*Acacia nilotica*) and Behan (*Populus euphratica*) have been replaced by *Prosopis juliflora*. The Hilaya forest situated near to the eastern bank of the Lake is under sever logging pressure by the nearby community. The locals are clearing land for agriculture purposes. The logging pressure as well as the scarcity of fresh water from Indus River is degrading the Sonda forest gradually. For the development of the RBOD the area of Sonda forest has also been cleared. Aquatic flora of the lake is comprised of Reed beds of *Phragmites karka*, *Typha angustata and, Persicaria glabra* and rich growth of submerged and floating aquatic vegetation including *Nelumbo nucifera (Kanwal)* and *Hydrilla verticillata*, *Potamogeton pectinatus etc.* These are present on the shallow areas of the bank. These shallow areas with good reed vegetation are often used by the fish and birds for the reproduction purposes. However, due to introduction of *Tilapia spp*. by the Fisheries department in the Lake the aquatic vegetation has declined.

Shallow waters of Kinjhar Lake are occupied by aquatic vegetation

Red stone: The locals for the mining of red stone are using the hill stones in the catchments area. The stones were never mined before and recently this practice has been started and majority of locals are involved after the depletion of the fish stock in the lake.

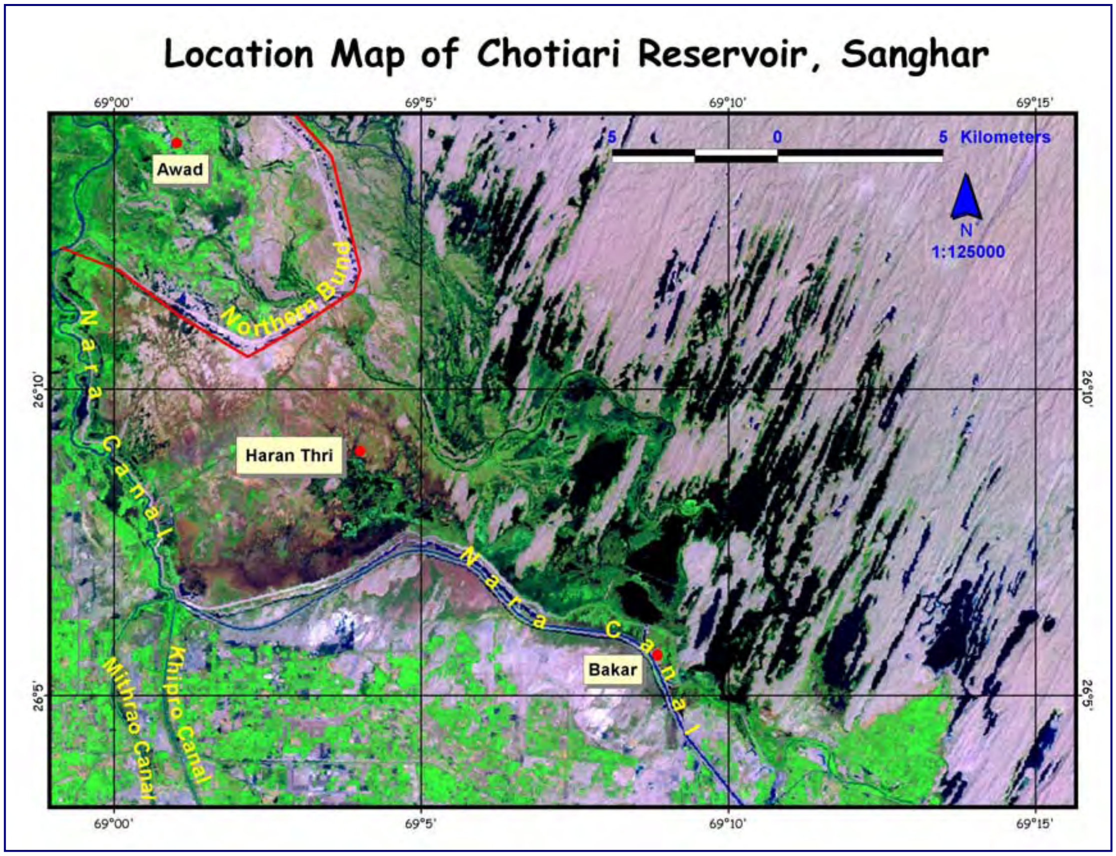
Agriculture: Rice, sugarcane, maize and vegetables are grown in buffer and adjacent areas of the lake.

1.1.3 Chotiari Wetland Complex:

Chotiari reservoir lies in the province of Sindh, on western flanks of Anchor Thar desert (white sandy desert) at about 30 - 35 km north-east of Sanghar Town. The Reservoir occupies an area of about 18,000 hectares and has water storage capacity of 0.75 Million Acre Feet (MAF) flooding an area of approximately 160 km^2.

Chotiari reservoir is created in a natural depression that exists along the left bank of the Nara canal. The depression area is bounded by sand hills towards north, east and south-east, while towards the west and south lies the Nara canal.
This reservoir is established to provide drainage facilities to the area and to improve the irrigation supplies during lean months when Indus flows are at minimum. It is an off canal storage reservoir retaining Indus flood water collected during the peak flow

period (June to September) and releasing it for use during the dry season (mid October to mid April). This reservoir will be filled from the Nara canal through a 6,500 cusec capacity channel, the Ranto Canal, off-taking from the Nara Canal at Jamrao Head.



The reservoir land area lies within seven dehs (cluster of villages) viz. Makhi, Haranthari, Bakar, Akanvari, Khadvari and Phuleli. The aquatic features of the reservoir area comprise diversity of small and large size freshwater and salty lakes, smallest being of 1 Hectare area and largest of about 200 Hectares which occupy about 30% of the total reservoir area. These lakes are a source of subsistence and commercial fisheries for the local people.

The area has a hot arid climate. The hottest months are May and June when average maximum daily temperature exceed 40°C. The coolest months are December to February, when the maximum daily temperatures range from 25 to 30°C. Rainfall is sparse and erratic and is most frequent between July and August when it averages 40 mm monthly. Annual average rainfall is about 125 mm. Floods are common in monsoon season. Evaporation averages 11 mm per day in summer, falling to 2.5 mm per day in winter. Annual average evaporation is about 2250 mm.

The local population is engaged in fishing, agriculture, jobs in different sectors and livestock rearing. A large area is being used for livestock grazing, which is a major occupation for the local communities. According to one estimate, nearly 400 families are associated with livestock rearing in the reservoir area. The majority of livestock includes, buffalo, cattle, goat, sheep and camel. A variety of non-timber forest produce that grow naturally in the reservoir area are used by local people for hut making, mat making, sweep sticks, roof thatching, medicinal and food purposes. Women living in those areas where reeds are abundant are associated with mat making as a source of their livelihood.

State of Biodiversity:

Chotiari is a rich ecological site and a unique habitat of wetland, riverine forest, desert scrub and sand dunes. This area is formed from several small natural lakes (dhands) and inter-dunal depressions that protrude finger-like into the western margins of the Thar Desert. Depth of water in the lakes ranges from shallow (less than 6 feet) to deep (30 to 45 feet). The edges of the lakes present a mosaic of reed beds which lie alongside alluvial fans, irrigation channels, riverine forests, desert dunes, swamps and agricultural land.

Fauna: The open wetlands and terrestrial areas are habitats for variety of fish, mammals, birds and reptiles.

- **Fish:** Chotiari is now producing fish weighing about 525 tonnes per year. In 1997, Sindh University conducted a study of fish fauna and recorded 31 fresh water species.
- **Mammals:** Hog deer, Chinkara, Jungle cat, Fishing Cat, Caracal, Smooth coated otter, Wild boar, Mongoose, Desert hare and Squirrels are reported in the area. A survey of Hog deer during the period May – October 1997 estimated that about 90 animals live along the western side of reservoir from Makhi Weir to Akanwari Deh. The gradual decline in vegetative cover has resulted in degradation of natural habitat of the Hog Deer whose wild population has declined severely.
- **Birds:** Chotiari lakes are important habitat for a variety of bird species. As many as 107 species of birds have been recorded from the area. Two species of birds found in the area are worth mentioning. The Marbled Teal is globally threatened but significant population has been reported to winter and breed here. Sindh Warbler is a rare species that have been reported from this area. The area was significant for migratory water birds. In a survey in 1993, 40,000 birds were observed in this area.
- **Reptiles:** About 50 marsh crocodiles were recorded in Makhi area in 1997. Python, a vulnerable species is also known to occur in the area but its present status is unknown. Varieties of snakes and lizards are found here.

Flora: Aquatic vegetation includes *Typha latifolia, Typha angustata, Phragmites karka. Ipomoea aquatica, Nymphaea lotus, Nelumbo nucifera, Polygonum sp., Urticularia lotus, Numbeum nuciferum.* The Riverine Forest has canopy of *Populus euphratica, Dalbergia sisso, Prosopis cineraria, Acacia nilotica* and *Zizyphus mauritiana*

Cultivated crops are generally cotton (kharif season) and wheat (rabi season), augmented with rice, sugar cane, animal fodder and vegetables.

1.1. 4 PAI FOREST:

Prior to British era in 1943, the local rulers (Talpur/Mirs) in Sindh owned all the well-stocked forests in the province, who maintained them as game reserves. The cutting of trees in such forests was strictly prohibited. Creation and demarcation of state forests as reserve and protected forests was started in 1823 and continued till 1972. Pai Forest is situated near Sakrand (Distt. Nawabshah in Sindh Province) at a distance of about 5 km and adjacent to National Highway. Climate of this area is generally hot and arid. Rainfall is scanty, erratic and mostly occurs during monsoon season *i.e.,* from June to September. The average annual rain fall is about 200 mm. Maximum temperature in summer rises to 50^{o}C, and minimum temperature during winter is 8^{o} C. Hot summers usually extend from April to October. Soils of this area are mostly loam with varying proportions of clay and sand. At some places it is saline which is due to the rise in water table.

Prior to the construction of Sukkur barrage on river Indus at Sukkur, Pai forest depended for its water supply on the scanty rainfall and the unregulated water supply from the river through inundation channels. As water supply was not assured, the growing stock was poor both in quality and quantity. The Barrage was constructed during 1931-35, but no provision was made in it initially for supply of water to the Pai inland forest. Raising of tree plantations under agro forestry system was, however, started in 1937-38 with the help of irrigation water. As water supply was small, only small areas of 20 to 40 ha were taken up each year for raising tree crops. This arrangement continued till 1946-47. Due to construction of flood protection bund along the river, Pai forest was cut off from the riverine areas and became inland forest. Thus this inland forest is situated outside the river embankments.

Realising the gravity of the shortage of fuel-wood and charcoal in the province in 1946-47, the Government of Sindh sanctioned irrigation water from Rohri canal for maintaining Pai forest. It is presently partly irrigated by canal water and partly by lift irrigation.

Pai forest, was taken up for systematic conversion into irrigated plantation during 1960-61 under a development scheme titled "Industrial Wood Plantation Phase-I". An area of 506 ha was planted under this scheme. In addition, an area of 174 ha was planted under Industrial Wood Plantation Phase-II in 1988-91 and 455 ha have been planted under SFDP since 1996-97. Most of the areas planted with Shisham during 1960-61 to 1969-70 under first development scheme were invaded by Kandi due to fires and shortage of canal water. Therefore, 13 tube wells were installed in Pai plantation to irrigate the plantation in time of water shortage.

Most of the trees are giving a dry look due to shortage of water in Pai Forest

State of Biodiversity:

Pai forest has a total area of 1933 ha (4777 acres). Out of the total area only 1502 ha (78%) are under tree cover while remaining 319 and 112 ha are either blank or on high lying areas, respectively. Presently 338 ha (17 %) are under Babul (*Acacia nilotica*), 107 ha (6 %) under *Eucalyptus*, 1045 ha (54%) under Kandi (*Prosopis cineraria*) and 12 ha (0.6%) under Shisham (*Dalbergia sissoo*) crop. Thus a total of 457 (24% of the total area) is irrigated and maintained as Irrigated plantation while remaining (54 %) that is comprised of Kandi (*Prosopis cineraria*) trees and do not receive irrigation water.

Pai Forest has four major species; Kandi (*Prosopis cineraria) (very common with pure stands), Babul (Acacia nilotica) (common), Eucalyptus camaldulensis (Common on northern and NE sides), Tamarix indica (Common) and Tamarix aphylla (occasional).* Other plant species in the area include *Salvadora oleoides, Salvadora persica, Calotropis procera, Cadaba farinosa, Zizyphus nummularia, Capparis decidua, Amaranthus graecizans, Cucumis melo var. agrestis, Zaleya pentandra, Solanum surattense, Corchorus tridens, Corchorus depressus, Abutilon indicum, Amaranthus viridis, Launaea procumbens, Brachiaria spp., Suaeda fruticosa, Rhynchosia minima,* *Mullogo pentaphylla, Salsola imbricata, Dactyloctenium aegyptium, Desmostachya bipinnata, Trianthema portulacastrum, Euphorbia prostrata, Eclipta alba, Eragrostis japonica, Eragrostis minor, Cleome brachycarpa, Aerva javanica, Cocculus hirsutus and, Verbascum thapsus.*

Intensity of infestation of alien invasive species like Mesquite (*Prosopis juliflora*) could be visualised from the fact that in most of the sampling points it stood second to the main species forming community. In three out of nine sampling points, Mesquite was the most dominant species and hence plant communities were named after this (Table 81).

Illegal wood cutting is common in Pai Frest

Pai Forest has a number of wildlife species, which include Indian Pangolin (*Manis crassikandata*), jackal (*Canis aureus*), Jungle cat (*Felis chaus*), Hog deer (*Axis porcinus*), Black partridge (*Francolinus asiac*) and Grey partridge (*F. pondicerlanus*) *etc.* Pai plantation is managed as Partridge game reserve.

1.2 Objectives of the Studies

1.2.1 Natural Vegetation Assessment:

1. Compile floristic inventory of selected habitats within each of the four IFAP sites and enlist the important plants of potential economic significance.
2. Conduct phytosociological studies for delineation of plant communities.
3. Assess the carrying capacity of representative sites of IFAP.
4. Analyse threats to natural vegetation and present recommendations for vegetation management and habitat recovery for long term biodiversity conservation of each site.

1.2.2 Large Mammals Assessment:

1. To prepare a checklist of large mammals, distributed in the area and determine status of each species.
2. To assess threats to the large mammalian species.
3. To review literature related to large mammalian species.

1.2.3 Small Mammals Survey:

1. Prepare a list of small mammals species based on field observations, sampling and secondary data.
2. Identify habitats for key wildlife species
3. Assess abundance and distribution of key wildlife species.
4. Determine biology, behavior, breeding season, habitat requirements and feed requirements for all relevant species based on secondary data.
5. Identify, and if required, evaluate present threats to relevant species and their habitats.
6. To identify distributional patterns and habitats of the small mammals in the study area.
7. To identify the key species of small mammals inhabiting the area.

8. To identify impact of small mammals on the overall livelihood of the people.

❖ Scope of the present studies:

Small mammals are unique in the sense that:

i- They have very limited home range and are vulnerable to the localized changes as construction of roads, houses, fires, lights or any kind of habitat destruction and disturbance.

ii- Small mammals have a variety of habitats. Some of them live in the burrows, some in agricultural fields and on the trees, the others temporarily invade the holes of the other animals, some live in the crevices, some hide themselves in the bushes, grasses and exposed roots of the trees, and some do not prefer to have a permanent living place but are opportunist settlers and keep on changing their living place. As they occupy a variety of habitats, they have different kinds of associations with humans at every place.

iii- The small mammals are the back bone of the ecosystem as they feed on the most inferior quality food in the form of fallen seeds, decomposing plant material, fallen flowers, roots, spiders and scorpions and convert them in the form of a rodent flesh eaten by birds of prey, snakes and the carnivores which themselves are not only important as component of the wildlife but also play a role in the biological control of the natural ecosystem.

1.2.4 Ichthyological Survey:

1. Enlist and describe existing resident and migratory fish resources, their abundance, diversity and habitats in the study area.

2. Prepare a taxonomical checklist of all the species with their English and local names and their status in the core and buffer zones.
3. Help in developing GIS based information regarding occurrence and distribution of fish fauna.

4. Document the anticipated changes to resident and migratory fish population in the study area.

5. Document and describe fish species of “special concern” regarding the economic and ecological perspectives found in the study area.

6. Suggest suitable methods of monitoring fish in the core and buffer zones of the study area.

7. Conduct a local survey of the fishermen to assess the trends of fish production for the last ten years.

8. Develop simple indicators for assessing the population trends of the fish that can be applied by the local staff in future.

9. Describe and assess potential anthropogenic impacts on fish species found in the study area.

1.2.5 Avi- Fauna Survey:

1. Preparation of a rapid species inventory of the resident and migratory birds with notes on relevant occurrence and distribution for the study area.

2. Assess anthropogenic impacts on bird species found in the study area

1.2.6 Limnological Study

- Wetland Ecological assessment including detailed documentation and analysis of Macro and Micro fauna in the prioritized sites of two freshwater bodies; Kinjhar lake and Chotiari Reservoir and the Keti Bunder the coastal wetland.
- Conduct initial ecological surveys to give the overview of the selected sites to initiate the further conservation initiatives for their improvement.

1.3 Literature Review:

1.3.1 Natural Vegetation Assessment:

All the four sites mentioned earlier fall within the Indus Ecoregion. *"Eco-region is defined as a region which is relatively large unit of land or water that contains a distinct assemblage of natural communities, sharing a large majority of their species and ecological dynamics, share similar environmental conditions and interact ecologically in ways that are critical for their long term persistence"* Ahmad (2004*).* The concept of *"Eco-region"* stemmed from the WWF's Global 200 Eco-regions developed on science-based ranking of the earth's most outstanding terrestrial, freshwater and marine habitats to serve as a blue print for conservation of biological diversity at global scale Ahmad (2004*).*The Indus Eco-region has been identified as one of such sites in G200 based on its diverse spectrum of coastal, lowland and mountain vegetation and habitats. It partially or fully covers several districts of Sindh province including Thatta, Badin, Hyderabad, Dadu, Nawab Shah, Sanghar and Umer Kot. The Delta itself, that mostly lies in Thatta district covers an area of about 60, 000 ha. The vegetation of the Indus Eco-region is Saharo-Sindian Type (sub-arid scrub) (Stewart 1982, Ali & Qaiser 1986). While mentioning the Sindh Flora, Stewart (1982) mentioned that "Sindh is a continuation of the great desert belt, south of the Mediterranean, stretches clear across North Africa, Arabia, and southern Iran to the foot of Himalyas along the Indus and its great tributaries. Some of these Saharo-Sindian plants are found in the Kashmir valley at 1600 m. This North African desert flora is also dominant in the Great Indian Desert to the south of Sindh and Punjab deserts. In Balochistan it is found in the coastal plain and up to c. 1400 m". Sindh has four distinct vegetation zones *viz*., (i) Tropical Thorn Forest with small and sparsely scattered trees with little ground cover. The main plant species are Khabbar (*Salvadora pesica*), *Salvadora Oleoides*, Babool (*Acacia nilotica*), Ber (*Zizyphus mauritiana), Zizyphus nummularia*, Kandi (*Prosopis cineraria*) and Lai (*Tamarix* spp.). The original tropical thorn forest is, however, mostly replaced by the agricultural lands, diminishing many useful species of the forest like *Salvadora oleoides*. Therefore, the Tropical Thorn forest in the subcontinent (Khan 1994), with its remaining parts continuously falling prey to expanding agriculture, forestry, human settlements *etc.* (ii) Riverine forests comprising *Acacia nilotica, Populus euphratica, Prosopis cineraria* and *Tamarix* spp. (iii) Wetland vegetation dominated by Phragmites, Typha, Nelumbo, Nymphaea, and other aquatic flora and (iv) Coastal vegetation comprised mailny by mangoves such as *Avecinnia marina, Aegicerus corniculata, Ceriops tagal* and*, Rhizophora sp.* Stewart (1982) mentioned that Sindh is much like Egypt. It is a deser through which a great river flows and life of the regionh is dependent on the water of the Indus River as Egypt is on that of the Nile. Most of the area around Indus in Sind roughly 70 – 80- miles on each side of the river is great alluvium plain. Most of the entire region in Sindh does not rise 200 m in elevation. There are areas of desert scrub which cannot be irrigated from the Indus due to its higher levels and there are about 1200 square miles of riverain forests. Stewart (1982) further mentioned that flora of Sindh is poor compared with that of the rest of the areas of Pakistan becuase of fewer habitats and less climatic and altitudinal variations. Inspite of this limitation, flora of Sindh is of great interest and there are many different habitats to provide a number of different floras. There is no up-to-date checklist of the flora of Sindh. During the British period which ended in 1947, Sindh was an appendage of Bombay. Therefore, most of the plant collection were done either by Army men or civil government servants. Good work was done by Rev. Ethelbert Blatter, S. J. (1877 – 1934), a Swiss who compiled the Flora of Indus Delta in which he listed 332 taxa of which he thought 279 to be natives. Of these 40 were grasses, 23 legumes, 18 *Compositae*, 13 *Convolvulaceae*, 11 *Euphorbiaceae, Amaranthaceae* and *Cyperaceae*. He mentioned poverty of *monocots*. Blatter considered 60 taxa were North African and 39 Tropical African. He considered 39 to be Old World Tropical, 29 to be Indian, 16 Indo-Malayan and 22 from war countries. Blatter thought 6 might be endemi and the rest to be miscellaneous Stewart (1982).

Indus Delta:

Indus Delta comprising almost 30,000 km^2 is a triangular area. It is about 240 km in length along axis of the Indus. It comprises of 17 major and numerous minor creeks, extensive area of mud flats and about 160,000 ha of mangrove forests. The delta holds 97 % of the total mangrove forests of Pakistan and nearly 95 % of the total mangrove cover in the delta is comprised of *Avicennia marina.* Indus Delta mangroves are unique being the largest area of arid climate mangroves in the world. (Anwar 2004., Hoekstra *et al.* 1997). Anwar (2004) mentioned that historically, mangroves in the Indus Delta were never managed scientifically. These were used as hunting grounds by Talpur rulers and after creation of Pakistan they came under the control of the Board of Revenue which further distributed some land to Sindh Forest Department and the Port Qasim Authority. Hoekstra *et al.* (1997) stated that the people living in Indus Delta mangrove ecosystem are by birth Sindhi and belong to two main tribes; Mirbahar and Jats. Jats are further sub-divided into Dabbay and Faqirani. In Keti Bunder area people mainly belong to Baloch, Jat, Memon, Shaikh, Ganbeer, Badala, Dabla, Solangi, Sayed and Gugaand tribes. Most of the permanent settlements in Indus Delta are situated where drinking water is available. Some of the fishermen from such settlements reside temporarily in mangrove area either on their boats or in temporary structures. In Keti Bunder area settlements are situated either within mangroves or near inland.

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. The authors further mentioned that mangrove vegetation is characterised by a woody plant formation consisting of *Avicennia marina*, *Ceriops tagal* and *Aegiceras corniculatum*. However, density varies between places. *Avicennia marina* is the dominant composition and occurs as almost monotypic stand throughout the area. This species attains about 10 m height in the regularly inundated areas. With the increase in elevation and decrease in flooding frequency by the tides, the tree height reduces greatly and takes a bushy appearance. *Ceriops tagal* and *Aegicerus corniculatum* are found on relatively high ground particularly along the raised levees. In the soft substratum flooded regularly by the tides, *Porterasia coarctata (Oryza coarctata),* locally known as Son grass, forms a grass vegetation type. This grass community is considered as a pioneer stage in mangrove succession. *Aeluropus insignis* (locally called Lunando grass); a halophytic grass also forms distinct vegetation type in the raised land. Hoekstra *et al.* (1997) mentioned that salt marshes vegetation is characterised by halophytic vegetation consisting mostly of *Arthrocnemum indicum*, *Suaeda fruticosa* and *Tamarix dioica*. Authors presented their findings about the land vegetation types in the form of a table reproduced below.

Table 2: State of terrestrial vegetation in Indus Delta

Land Vegetation Type	East Shah Bunder	Central Shah Bunder	West Shah Bunder Kharochan	Keti Bunder	East Karachi	Port Qasim
Mangroves	Dense	sparse	Sparse	sparse	medium	Dense
Mud flanks / Blanks	Large	Large	Large	Large	medium	Small
Salt Marshes	Large	Large	Large	Large	Large	Small
Sand dunes strand	Small	small	Medium	medium	small	large

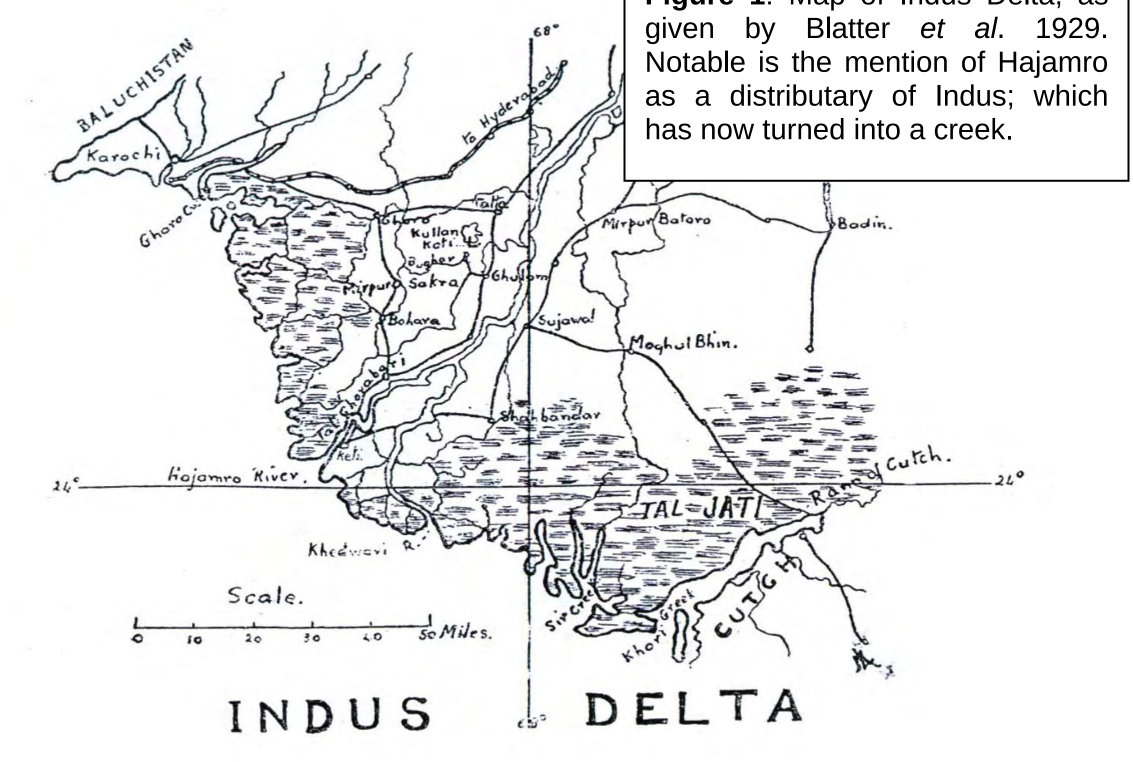
Blatter *et al.* 1929 compiled “The Flora of Indus Delta” which not only provides a historical overview of the vegetation in delta region but also enables plant scientists to compare recent floristic composition with that of 1929 and examine vegetation changes, if any, with respect to human and natural causes. Authors documented an overall 332 plant species in the Indus Delta (279 indigenous and 53 introduced) belonging to 220 genera and 61 families. Out of these, 211 and 67 species belonged to dicotyledons and monocotyledons, respectively. Authors summarized dominant plant families in the Indus Delta in the following table. The data reveal that Gramineae and Leguminosae were the largest families representing 14.3 % and 8.2 % plant species, respectively and Cucurbitaceae and Solanaceae being the smallest, each representing only 2.5% of the plant species of the Indus Delta.

Table 3: Floral Composition of Indus Delta in 1929 (Blatter *et al.* 1929)

Families	Species	Percentage of the total	Families	Species	Percentage of the total
Gramineae	40	14.3	Malvaceae	10	3.5
Leguminosae	23	8.2	Boraginaceae	9	3.2
Compositae	18	6.4	Tiliaceae	8	2.8
Convolvulaceae	16	4.6	Asclepiadaceae	8	2.8
Euphorbiaceae	11	3.9	Chenopodaceae	8	2.8
Amaranthaceae	11	3.9	Cucurbitaceae	7	2.5
Cyperaceae	11	3.9	Solanaceae	7	2.5

Blatter *et al.*, 1929 further mentioned that out of 279 species that made up the flora of the Indus Delta 226 species were found in other part of Sindh, as well. There were only 54 species which are not found in extra-deltaic Sindh. They added further that there were 6 endemic species that included *Gossypium bakeri*, *Asparagus deltae*, A. *gharoensis, Periploca sp., Convolvulus sp. and Andrachne sp.* The later three were believed to be new species which they planned to describe later.

Figure 1: Map of Indus Delta, as given by Blatter *et al*. 1929. Notable is the mention of Hajamro as a distributary of Indus; which has now turned into a creek.



Source: Modified after Blatter *et al.* 1929.

Most dominant genera in Indus Delta include *Euphhorbia, Heliotropium, Cyperus, Abutilon, Indigofera, Tamarix, Grewia, Corchorus, Crotalaria, Acacia, Ipomea, Solanum, Barleria, Suaeda, Asparagus, Saccharum, Echinochloa, Eragrostis and Eleusine (Octhochloa).* Authors treated Mangroves of Indus Delta separately and mentioned presence of eight species that included *Rhizophora mucronata, Rhizophora conjugata Ceriops candolleana, Ceriops roxburghiana, Bruguiera gymnorhiza, Sonneralia acida, Aegiceras majus and Avicennia officinalis.* The most notable point is that they did not mention *Avicennia marina*, which at present forms 95% of the Indus Delta mangrove forest. They mentioned *Avicennia officinalis*, which is a comparatively less salt tolerant species, and not found in Indus Delta at present. This may indicate the enormous ecological change that occurred over the past eighty years. Authors provided a detailed account of species with respect to different physiographic units and covered vast area now comprising Thatta district (including current Badin district) and up to the boundaries of Karachi and Hyderabad districts. They mentioned that in Keti Bunder species like *Tamarix troupii, Thespesia populnea, Ipomoea aquatica, Peplidium humifusum, Tecomella undulata, Phyllanthus distichus, Cocos nucifera, Phoenix dactylifera, Pandanus tectorus, Cyperus tegetum, Echinochloa Crus-Galli,* *Phragmites Karka and, Oryza coarctata were widely present.* Authors mentioned that in Hajamro River (now creek) they found *Aeluropis villosus* grass and eight species of mangroves namely *Rhizophora mucronata, Rhizophora conjugata Ceriops candolleana, Ceriops roxburghiana, Bruguiera gymnorhiza, Sonneralia acida, Aegiceras majus* and *Avicennia officinalis*. Unfortunately today we find only one species of mangrove *Avicennia marina* and that is also in juvenile stage in Hajamro creek. Authors also reported dense forests of *Populus euphratica* and *Acacia farnesiana* in Hajamro creek which are absolutely absent now.

Saifullah (1997) while discussing management of Indus Delta mangroves mentioned that in fact management of coastal zone of Indus Delta is management of mangroves. As late as 1980s mangroves grew all along 240 km long coastline and occupied approximately an area of 600,000 acres (40% of the entire tidal belt and 10% of the Indus Delta fan) and they were rated as the 5^{th} or 6^{th} largest mangrove forests of the world and certainly the largest in the arid climate. However, due to extreme tampering in the environment both in the upstream area and the Indus Delta itself, these mangroves are disappearing at a faster rate. Author presented a detailed account of the economic, social and environmental benefits of mangroves and discussed various causes that have lead to the deterioration of this important ecosystem.

Estuaries present a unique coastal ecosystem with typical environment and biodiversity which is different from general coast. Estuaries represent regions where fresh water of river mixes with the sea water (Khatoon *et al.* 2005). River estuaries are regarded as the areas where juvenile fish abode due to rich food and absence of predators. Both the terrestrial vegetation along the banks and the macrophytes greatly influence the riverine and estuarine ecosystems as the riverine contribution of organic matter exceeds 95% while the aquatic flora influences littoral phytoplankton, zooplankton, invertebrate communities, and fish communities (Smith and Smith 1998, Khatoon *et al.* 2005). Sohag (2001) defined estuary as the area where river water mixes and dilutes the sea water. He pointed out that it is difficult to precisely locate the merging point of river and sea water due to varying river discharges, tidal actions and wind forces. However, in case of Indus, the upper limit of estuarine area starts at certain distance downstream of Kotri Barrage.

Wetlands:

Imran & Khatoon (2005) mentioned that wetlands are those areas where inundation must take place at least for 14 days and saturation for 60 consecutive days. They further mentioned that there are various types of wetlands such as wooded land, peat land, flood plains and, mangrove swamps *etc.* Each wetland is rich in floral diversity; however, it is hard to define any wetland plant. According to a broader definition, all those plants that at least spend part of their life cycle in partially submerged conditions are regarded as aquatic or wetland species. Authors further discussed that in older times wetlands were considered as places where mosquitoes and other harmful insects reside but now with the growing understanding these areas have been recognised due to their diverse ecological services and useful living resources such as reducing silt load from incoming waters, reducing erosion by buffering wave action and harbouring fish, medicinal and edible plants and maintaining healthy web of life. Because of their actions for cleaning impurities from the system wetlands have been regarded as the kidneys of the landscape (Bush 1997). Sindh province has many wetlands which are either connected with River Indus or too many other seasonal rivers and streams. Some of these wetlands are of international importance such as Ramsar Sites like Haleji and Kinjhar lakes. A large number of migratory birds visit these water bodies for wintering. Although fish and other aquatic fauna and the water birds of these wetlands have been documented but inventory of the plant species, which are primary producers, is lacking (Imran & Khatoon 2005).

Wetlands in general are more diverse and more productive than other terrestrial ecosystems. The greater diversity is due to greater number of ecological niches because of water depth and nutrient levels that give rise to various vegetation zones such as free-floating hydrophytes in the deeper water, emergent aquatics rooted in mud towards the margins of wetlands, and semi-aquatic plants at the margins of the wetlands (Bush 1999, Khatoon & Ali 1999). The floral diversity supports myriad other life forms, ranging from zooplankton to insects and other invertebrates, fish, birds and mammals. Apart from housing unique wildlife, wetlands also provide a number of other benefits such as reducing floods, erosion and silt load and storing carbon and nutrients in the forms of biomass and serving as biological filter to remove the pollutants from the system thus purifying the water of lakes and rivers, therefore referred to as "kidneys of the landscapes" (Khatoon & Ali 1999). Leghari *et al.* (1999) conducted a study on biodiversity of Chotiari reservoir and mentioned that Chotiari reservoir is formed of a group of sub-tropical lakes and is located about 30 – 35 km on the eastern side from Sanghar town. The reservoir covers an area of about 37 km^2 and after completion of the entire work; it will cover about 86 km^2 areas. The reservoir is interconnected between several lakes namely Bakat, Gun Wari, Tajar, Phuleli, Seri and Sao Naro. These lakes are surrounded by Nara canal which is a major source of water to these lakes. On the eastern side, the reservoir extends into the Thar Desert. The reservoir has a depth from 3 to 26' with sandy silty and muddy bottom which provide a suitable surface for the growth of algal and aquatic plant species.

Leghari *et al.* (1999) further reported that very little work is reported on the Chotiari reservoir. Authors while disseminating the results of their study mentioned that on the moist, water logged and swampy soil as well as in shallow water area species like *typha elephantiana, Typha domogensis, Phragmites vallotoria, Cyperus sp., Polygonium barbatum, Fimbristylis sp., Scripus sp., Ipomea aqutic, Marsilla minuta, Equiseam deble and Riccia sp. a*re found. Some of these species are used in packing and cottage industry for making mats. In the lakes there is a thick growth of submerged vegetation, they are with floating leaves and are important in the nutrient cycling and respiratory gases. They often provide very dense habitats which supply food and shelter to small organisms such as fingerlings and zooplankton. These plants also serve as a food source of migratory waterfowl and fishes. The major submerged plants are *Ceretophyllum demersum, Najus sp., Utricularia auro, Potamogeton sp., Hydrilla verticillata, Myriophyllum tuberculatum and Villisinaria spiralis.*

In the shallow and deep water there is growth of plant *Nelubium* nuciferum, *Nelumbum nelumbum* and*, Nymphaea lotus*. The parts of these plants are used as human food. The plants floating on the water surface include species like *Riccia carporus, natans, Azolla pinnata, Salkvinia molesta, Spirodella polyrhiza* and *Lemna sp.*

Riverine Forests & Irrigated Plantations:

Riverine forests are one of the important ecosystems of Sindh. These forests along river Indus get annual inundation during monsoon. Khan & Repp (1961) mentioned that ecological conditions in these forests are very favourable. Annual flooding leave the soils in these forests saturated for rest of the year for luxuriant plant growth. By March, seven months after flooding, soil still have 18% moisture content by fresh weight. The vegetation in riverine forests is much influenced by the frequent change in erosion and deposition due to changing course of the river Indus. The pioneer vegetation on newly deposited soils consists of species such as *Saccharum* bengalense, *Saccharum munja, Saccharum spontaneum, Tamarix dioica, Tamarix indica* and *Populus euphratica.* Climax vegetation, however, is comprised of *Acacia nilotica, Prosopis cineraria and Cynodon dactylon.* Under arid conditions vegetation is comprised of species like *Prosopis cineraria, Salvadora persica, Salvadora oleoides, Capparis decidua, Acacia senegal, Acacia jacquemonti, Cymbopogon jwarancusa, Aristida sp., and Zizyphus nummularia etc.* Authors during their visit to riverine forest of Rajri situated at 20 miles north of Hyderabad found 20 – 25 years old graceful trees of *Populus euphratica* of 5 – 6 feet girth. Unfortunately, today we do not have even such stretch of vegetation in the entire lower Indus region that can be regarded as 'forest'. Ahmad (1953) described that forests in Sindh are of two types; one that situated inside flood embankment along river Indus are called Riverine Forests and those which are situated outside embankment are called Inland Forests. Riverine forests are further sub-divided into one called Pakko situated away from river bank and other which are situated near to the river bank on sand and silt deposits and called Kacho forests. Kacho area is flooded even with little rise in the river water. Author mentioned Babul (*Acacia nilotica*), Kandi (*Prosopis cineraria*), Bhan (*Populus euphratica*) and Lye (*Tamarix aphylla*) as the major tree species of riverine forests. While discussing the historical background of riverine forests of Sindh, Ahmad (1953) mentioned that before construction of Lloyd Barrage (Sukkur Barrage) during 1932-33, all the forests were open to inundation and there was plenty of water for forest growth. Forestry was considered as easy task just broadcasting the seeds of *Acacia nilotica* before Aabkalani (flood) season and clear felling the coupe after completion of crop rotation. After construction of Sukkur Barrage a protective bund along river Indus were constructed to safeguard the irrigation network, communication network and agricultural fields. By doing so some of the riverine forests got cut and separated rendering them incapable of flood water from the river Indus. Such forests are termed as the Inland Forests (Ahmad 1953, Khattak 1976). Qadri (1955) mentioned that one of the geographical features of Sindh is the river Indus that flows on a ridge almost through the axis of this region, with the country sloping away from this on both sides. On account of this unique feature, the countryside is always flooded when the water level in the river attains dangerous heights. To protect the countryside from floods, earthern banks were constructed at about 12 to 25 miles apart and generally the activities of river are contained within these bunds. The land in between such embankments are regarded as Riverine Forests and stretch over about half a million acres and are under the control of Forest Department. Qadri (1955) further mentioned that on an average 18000 acres of riverine forests are eroded every year by river Indus. However, almost equal amount of area is formed by the river every year, as well. Thus such erosions and accretions continue every year. Khattak (1976) while describing the history of riverine forests in Pakistan mentioned that major tree species in the northern zone in riverine forests is Kandi (*Prosopis cineraria*) while in southern zone, Babul (*Acacia nilotica*). Bahan (*Populus euphratica*) and Lai (*Tamarix spp*.) occur in zones, former on fresh alluvium and the latter in low lying areas. Babul requires inundation of about 2 – 4 feet annually for adequate growth and is replaced by Kandi in high lying areas which do not get inundation to this depth. Kandi predominates in the northern zone due to incidence of frost and low inundation as compared to the southern zone. Khattak (1976) further mentioned that edaphic factors in riverine forests generally determine the productivity of the forests and the species composition. Since edaphic factors keep on changing, therefore, it becomes difficult for long term planning of these forests.

Sohag (2001) described that riverine forests are an important land use closely associated with soil resources, water management, wildlife conservation and fisheries in addition to being an important sources of food and fodder.
The trees lying on the flood plain frequently require flood water for their growth. However, frequency of such discharges of the river has considerably reduced after the construction of upstream hydraulic structures. Due to gradual decrease of inundation, riverine forest area is shrinking alarmingly while less salt tolerant species have almost disappeared.

1.3.2 Small Mammals

There are several scattered reports on the study of small mammals of Pakistan Ahmad and Ghalib (1979), Akhtar (1958-60), Anthony (1950), Baig *et al* (1986), Banerji (1955), Beg *et al.* (1975, 1986), Frantz (1973), Fulk *et al.* (1981), Mehmood *et al.* (1986), Mian, (1986), Mirza (1969), Parrack (1966), Roberts (1972, 1973), Siddiqui (1970), Thomas (1920a,b,1923), Wagle (1927), Walton (1973) and Wroughton (1911,1920) but the most comprehensive and consolidate work is that of Roberts (1997). Roberts (1997) compiled all the information available on the mammalian fauna of Pakistan. After that Woods *et al.* (1997 a,b) gave a detailed account on the small mammals of Pakistan but their work was restricted to the northern mountain region of Pakistan. None of these studies have specifically addressed the mammals of lower Sindh.

1.3.3 Ichthyology:

Many diverse studies have been conducted on many aspects of fish and fisheries of the coastal areas of Pakistan. The major bulk of literature is on the biodiversity of various parts of the coastal areas. The significant work in this regards is that of Ahmed *et al.* (1976), Ali and Jafri (1986), Iqbal *et al.* (1999), Jafri *et al.* (1999), Jafri *et al.* (2000), Jalil and Kamaluddin (1981), Kazmi and Kazmi (1979), Leghari *et al.* (1999), Mirza (1986), Niazi (1976), Parashad and Mukerjee (1930), Qureshi (1965), Siddiqui *et al.* (1973), Sufi (1957, 1962). Some work on the commercial fishes has been conducted by Ahmed and Niazi (1988), Bianchi (1985) and Khan (1999). The limnological aspects of various water bodies have been covered by Baig and Khan (1976), Baqai *et al.* (1974 a, b), Dewani *et al.* (2002), Mahar *et al.* (2000) and Nazneen (1995). The water pollution in the coastal area has been documented by Amjad *et al.*, (1998), Monawar *et al.* (1999) while aquacultural aspect is badly lacking and the only work documented is that of Yaqoob (1994).

1.3.4 Limnology:

Many workers work on the water quality in respect of physico-chemical and microbiological characteristics, diversity of planktons. Khan *et al.* (2005 and 2006) investigated the drinking water quality of Hub River catchment area. He examined the microbiological, chemical and heavy metal analysis and found that the drinking water is not fit for the human consumption and polluted but chemical quality was acceptable.

Similarly the study by Khan *et al.* (2003) on the distribution of pollutants in the waters of Gharo Creek at Sindh coast pointed out that the results did not meet the standards of the NEQs (National Environmental Quality Standards) which leads towards the environmental degradation and impact on the biodiversity of the creek.

The pesticide pollution of Gharo Creek was examined by Khan *et al.* (2004). He found significant concentration of the commercially used pesticides.

The seasonal distribution of Phytoplanktons studied by Nazneen (1974) at Kinjhar Lake observed the eutrophic characteristics of the lake with high nutrients and abundant growth of Myxophyceae and diatoms (Pearsall, 1932; Beeton, 1965).

The physico-chemical study conducted by Nazneen and Begum in 1988 at Lyari River by taking different points found alarming level of pollution which impacted the diversity of fauna and flora of the River.

The blue green algae were first reported from the Kinjhar Lake by Leghari and Sultana (1992). The work done on the limnological aspect of Chotiari reservoir by Leghari and his co-workers (1999) concluded that the reservoir water quality was within the permissible limits and suitable for irrigation and fisheries production. Similarly the work done by Khuhawar *et al.* (1999) on Kinjhar Lake came up with the same conclusion about the Kinjhar lake water.

Mahar *et al.* (2000) observed the extensive population of cynobacteria in the Manchar Lake which ultimately deteriorated the water quality and harmful for the human consumption. Jahangir and his co workers (2000) studied the water quality of the Kinjhar and Haleji lakes observed that the water quality was satisfactory for drinking purpose and noted extensive growth of algae and higher plants.

Mahar *et al.* (2005) conducted physico chemical studies on the Manchar Lake and found that the water properties were far beyond the WHO drinking water standards and degrading the biotic life at the Manchar Lake. Similarly Mahar, Jafri, Leghari & Khuhawar (2004) studied the water quality of Manchar Lake and found the eutrophic condition of lake water.

Population of phytoplankton studied by Ramakrishnan *et al.* (2002) found that the 97.8% of the variation in phytoplankton density was influenced by physico-chemical factors of water. The study conducted by Reghunath and Zachariah (2002) evaluated the seasonal variation in the plankton population of Vembanad lake of Kuttanad ecosystem of Kerala and found that the phytoplankton population had one higher peak during pre-monsoon and a peak of diminutive magnitude during the monsoon and post monsoon. The zooplankton population showed the bimodal pattern of distribution with one peak during pre-monsoon and the other during post-monsoon.

The work done by Ali *et al.* (2003) on biodiversity in relation to seasonal variations in water of River Indus at Ghazi Ghat showed great variation in species of phytoplankton and zooplanktons due to weather conditions such as summer being more diversity as compared to the winter. The decrease water level in winter causes the deficiency in oxygen which affected the planktonic life. Similar studies carried by Salam and Rizvi (1999) with reference to biodiversity established the relation between water quality and planktonic life in Chenab River.

Another work done by Tassaduqe *et al.* (2003) on seasonal variations in physico-chemical and biological aspects at Kaloor Kot, Darya Khan, Ghazi Ghat, Taunsa Barrage, Chachran Sharif of River Indus showed both temporal and seasonal variations in water quality of River Indus. Tabinda, Moazzam, Hany and Ayub (2003) studied the relative abundance of planktons in relation to water quality of Degh Nullah and concluded that the water quality was suitable for the aquatic life.

SECTION 2

MATERIAL AND METHODS

2- MATERIAL AND METHODS:

2.1 NATURAL VEGETATION:

Methodology:

The methodology of this study is comprised of the following steps;

I. Comprehensive review of literature of baseline data about vegetation, ecology, socio-economic conditions and past management approaches of each site.

II. Detailed reconnaissance of each of the four sites for taxonomic and phyto-sociological analysis.

III. Brief socio-economic overview to determine the impact of anthropogenic activities on the natural vegetation.

IV. Working out the forage production, carrying capacity / grazing capacity in different parts of each site.

An extensive survey was carried out during September 16 – 23, 2006 for the collection of plant specimens from the project area. GPS (Global positioning System) was used in determining exact location of the sampling points. The species were identified with the help of various Floras (Jafri, 1966; Ali & Nasir 1989-1991; Ali & Qaiser, 1992-1998, 2000-2006; Nasir & Ali 1969-1989; Matthew, 1981-83; Batanouny, 1981; Boulos, 1991; Shetty & Singh, 1987 & 1991; Bhandari, 1987; Qureshi, 2005). Local inhabitants were interviewed in order to get vernacular names. Pteridophytes and gymnosperm species were identified following the work of Nakaike & Malik (1992).

Field vegetation parameters like plant composition, cover, frequency and density were recorded along each transect line of 50 m using the line intercept method (Canfield 1940) and placing 1 m^2 quadrate at every 10 m interval on the same transect. However, a 50 m x 50 m quadrate was used in Pai Forest due to density of trees that did not allow transect and also because of inadequate ground flora. Similarly, in Keti Bundar North where there are monoculture of *Avicennia marina* with dense canopy, no transects were laid out. Sampling in Keti Bundar was carried out in areas where there was some sort of floral diversity. Plant biomass was assessed by clipping the palatable vegetation falling in each quadrate and then taking mean biomass of 5 quadrates of each transect line of 50 m (Anon 1962, Anon 1968, Thalen and Junk 1979, Cook & Stubbendieck 1986, Saeed *et al.* 1987, Rashid *et al.*, 1988, Bonham 1989, Khan *et al.* 1989, Marwat *et al.* 1990, Wahid 1990; Dasti & Agnew 1994). In case of grasses, clipping was carried out leaving 30 cm stubble height while in case of palatable shrubs and trees only fresh growth of current year was removed (Holechek *et al.* 1989; ESCAP 1994). The fresh samples of clipped vegetation were oven dried at 60 ^{o}C for 48 hours to ascertain the dry matter yield (DMY) for each sample. The DMY was then being projected on hectare basis. Number of transect sites also varied from one place to another based on the diversity of plant species.

Cover, composition, frequency, relative cover, relative frequency, and relative density were determined using following equation (Shaukat *et al.* 1976; Chul & Moody 1983; Shukla & Srivastava 1992, Smith and Smith 1998).

$$\text{Cover (\%)} = \frac{\text{Total intercept length of a species}}{\text{Total transact length}} \times 100$$

Composition (%) = $\frac{\text{No of individuals of a species}}{\text{Total no. of individuals of all spp.}} \times 100$

Frequency (%) = $\frac{\text{No. of quadrates in which a species occurred}}{\text{Total no. of quadrates sampled}} \times 100$

Relative Cover (RC) = $\frac{\text{Total intercept length of a } sp.}{\text{Total Intercept length of all spp.}} \times 100$

Relative Freq. (RF) = $\frac{\text{Frequency of a } sp.}{\text{Total frequency of all spp.}} \times 100$

Rel. Density (RD) = $\frac{\text{Total individuals of a } sp.}{\text{Total no. plants of all spp.}} \times 100$

After assessing the above mentioned parameters, importance value (I.V.) for each species in each sample was calculated as under:

I.V. = Rel Cover + Rel. Freq. + Rel. Density

Summed Dominance Ration (SDR) for each species was calculated using following formula.

$$SDR = \frac{I.V.}{3}$$

On the basis of Importance Value or SDR, sampled vegetation was delineated into different plant communities. The community within each stand was named as the species having highest Importance Value irrespective of its habit. When two or more species closely approached each other in order of Importance Value, the community shared the names of these dominants. The name of the species with highest I.V appears first followed by other dominant species. The generic names of the dominants are used for naming the community provided they do not overlap. Species other than the dominants were classified into co-dominants, associates and rare. During the vegetation sampling, phenology of the plant species was noted and photographs taken. Soil samples at 30 cm depth were also taken for subsequent analysis of macro nutrients and soil texture.

Multivariate and Diversity Analysis:

The cover estimates of all the species recorded at each of three sites; Keti Bunder, Kinjhar and Chotiari were examined using Two Ways Indicator Species Analysis (TWINSPAN), as a classified technique following the procedures of Hill (1979). Species richness (α-Diversity) of each of the vegetation cluster with each of the four sites (Keti Bunder, Kinjhar, Pai Forest and Chotiari) was calculated as the ratio between the total numbers of species recorded at a given site and its β-Diversity (Al-Sheikh and Ghnaim 2004, Jafari *et al. 2004*, Kalin-Arroyo *et al.* 1995, Smith and Smith 1998).

α, β and γ-Diversity:

These were measured in terms of species richness, *i.e.,* the number of species irrespective of the relative abundance of individual species. Therefore α – diversity is simply the number of species in one locality, the γ-diversity was calculated by adding the four α – diversities (*i.e.,* number of species in each locality or study site) but avoiding duplicate counting of species common to two or more localities.

The similarity index (CC) between locality points was calculated by the formula:

$$CC = 2S_s / S_j + S_k \qquad \text{(Sprensen 1948)}$$

Where S_s is the number of species common to both the localities, while S_j and S_k are the number of species in locality 1 and locality 2, respectively.

- The β – diversity was calculated as $\beta = \gamma/\alpha$ or $BD = S_c / S$, in which S_c is the number of species in a composite sample (combining α samples) and S is the mean number of species in α-samples (Whittaker 1972).. For comparing locality pairs, S_c was taken as the total number of species in the two localities excluding duplicate counting of shared or common species, while S was calculated irrespective of duplication.

Carrying Capacity:

Carrying capacity is the maximum stocking rate possible without inducing damage to vegetation or related resources such as soil, water and wildlife (Huss. 1979).

For calculating "Carrying Capacity" following steps have been taken into account (ESCAP 1994).

- Determined available dry matter forage (kg/ha) for each plant community.
- Worked out animal intake considering one cow weighing 350 kg as one animal unit (AU) that requires 7 kg dry matter forage / day or 210 kg dry matter forage per month.

As a general rule, 40% of the available forage was considered as "Proper Use Factor (PUF)" considering "take half and leave half".

Time frame and Phasing

Since this exercise was carried out to establish preliminary baseline, therefore, minimum number of days were spent on each site, as under.

Keti Bunder:	September 16 – 18, 2006
Kinjhar:	September 19 – 20, 2006
Chotiari	September 21 – 22, 2006
Pai Forest:	September 23 & then October 17, 2006

2.2 - LARGE MAMMALS ASSESSMENT

A - Marine Mammals:

Survey Methodology:

A transect was used to carry out survey by boat. Medium sized motor boat was used for the survey. The boat speed was maintained below 12 knots and the width of transect was 250 m on either side of the boat. Two observers and one recorder worked at a time. Each observer watched 90° in an arc sweeping one-quarter on front view from mid boat. Auto focus binoculars were used for observation and the data was recorded on the Cetacean Sighting Recording Protocol (Appendix I of Large Mammals report).

The local fisher knowledge of marine dolphins and porpoises was gathered using protocol/proforma designed for the purpose (Appendix II of Large Mammals report).

B - Terrestrial Mammals:

Survey Methodology:

A preliminary reconnaissance was made to observe the general conditions of the area. Surveys were carried out at night as most of the larger mammals occurring in the area are active at night. Strip or Transect method was used for making observation. For practical reason, the comprehensive survey was not possible in the stipulated time. Therefore, transects in randomly selected samples in different terrestrial habitat types available in the area were undertaken. Each transect was about 1 km or 1000 m long and visible distance on both sides of the line was about 10 m. Thus the area of each sample was 20,000 m^2. The transect observation was also done by driving vehicle at a low speed through the strip at night within the selected areas. Altogether 5 transects of about 1000 m length was undertaken. Signs, indices of large mammalian species was also recorded along transect as well as direct observations made. The data was recorded on the protocol designed for the purpose (Appendix III of Large Mammals report).

2.3 - SMALL MAMMALS SURVEY

Survey Methodology

i- Bait used

A mixture of different food grains mixed with fragrant seeds was used as bait for the attraction of the small mammals. Wheat and rice were used as food grains while peanut butter, coriander, oats and onion were used for fragrance. This bait was found highly successful in the study area probably due to overall food shortage and also because four ingredients used for fragrance. Freshly prepared bait was used on every trapping day. Only small amount of bait was put on the rear side of the traps. The care was taken while putting the bait in the rear side of the trap to make sure that bait was placed on the platform fitted on the rear side of the trap for this purpose.

ii- Traps and trapping procedure

Sherman traps were used for the present studies to collect the live specimens. Fifty traps were set at a specific area on a line approximately 500 m long and traps were set approximately 10m 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.

iii- Data collection

The traps were checked on the next day as early as possible. The trapped animals were carefully transferred one after the other into an already weighed transparent polythene bag. Utmost care was done to avoid direct handling and harassing the specimens. The species of the trapped animal was noted. The polythene bag along with the specimen was weighed and net weight of the animal was noted in the note book.

The sex of the specimens was also observed and noted carefully. Necessary relevant data as date of trap setting, date of data collection, habitat, location, elevation and weather conditions were recorded at the spot on the data sheet.

2.4- REPTILIAN STUDY

Survey Methodology

The following techniques were employed for the observation and census of reptiles and amphibians during the field survey:

a. Direct Counting:

❖ ***One – hour plot searching:***

At each site, a one hour search was carried out to detect as many reptiles and amphibian species as possible within a circular central zone. This consists of searching approximately 20 ha, (within a 250 meter radius of the sampling points) for one hour exactly and recording the number of individuals seen.

This method is suitable for counting the number of species of lizards, snakes and toads. At first, the suitable place with suitable habitat is chosen. Nearly 1 sq. km area is taken for the study. Some lizards and snakes are diurnal that is they come for their movement and food in the daytime just after one or two hours of sunrise. *Agama* and *Lacertids* are the best examples of diurnal lizards. Some are nocturnal, which are seen only at night just after sunset. Geckos and Snakes are the best examples of nocturnal reptiles. Their home range is not too far. They mostly live or move near their shelters either hiding inside the thick bushes or holes or crevices around the hills or mountains or freely move on the flat surface or on sand dunes.

The study is done all around one square km to see the surface of habitat and also under the shrubs. This practice is done at least for one hour to find different species of lizards and snakes. They are counted and identified in the field. It has been observed that where there are suitable habitats, abundant of herbs and shrubs, food mostly insects, the population of the species is satisfactory but on the barren field where there are few dry and scattered herbs and shrubs the population is very poor. In this way several square km of study areas are surveyed and finally the population of different species of lizards and snakes is estimated per square km. their exact location and home range is recorded by G.P.S so that when any observer and biologist or naturalist comes for study they can easily locate the place where the recorded or reported species are found. This method also helps to determine the distribution of species. Similarly night survey is done by the help of search lights and torches.

❖ ***Pitfall Traps***

Reptiles and amphibians are also detected using a line of Pitfall traps, invertebrates i.e. food of reptiles are also sampled using this technique. Each pitfall line consists of 30 meter of low, flexible nylon fencing pinned to the ground to divert the movements of small ground – dwelling animals mainly reptiles with six 3 – litre metal bucket buried in the ground with their lips at ground level along and below the fence, so that the fence straddled each bucket. The use of pitfall lines are restricted to sites where the ground surface is soft enough to dig or sandy areas. Pitfall lines are set for one night only. Team members reach early in the morning before sun rise and record the total number of reptiles of each species found in the bucket.

- ***Spotlighting or Night observation***

In order to detect some nocturnal snakes and lizards spotlight transects are conducted. Each transect is carried out after it is dark with a portable spotlight. Each transect is 3 km long. The same route is travelled on a return trip. In this way 6 km round trip is covered in one night. As soon as the species sighted, the time, approximate latitude and longitude and habitat type are recorded. This method is applied for catching reflection of crocodile's eyes. Observation by this method has been done at night in Nara Canal and Chotiari.

- ***Incidental Sightings***

Incidental sighting is helpful to determine the presence of the reptilian and amphibian fauna. In this way number of species, sex, age, date, time, latitude and longitude and habitat type are recorded.

- ***Turning of Stones, Rocks and Rotten Trees Process***

Nocturnal reptiles and amphibians take shelter or rest hiding themselves under the space of stones or rocks. Therefore in the day time survey of stones or rocks or rotten fallen trees are turned to locate and record the presence of species.

For snakes, lizards and toads the stone turning technique helps a lot for the location and estimation of population of different species to observers or biologist or naturalist. This type of method is used to find the nocturnal reptiles because in the daytime they hide and take shelter under the stones. Most of the species of snakes and lizards are collected by this method in the daytime because sometimes at night it becomes difficult to locate and find reptiles especially during the hibernation period in winter season. It is only applied when the sand and earth become very hot and they hide in a cooler place under the stones or slabs. Some times eggs of lizards and snakes are found under the stones. The observers should place the removed or turned stones in the same position and at the same place like natural condition so that the natural habitat and ecological condition may not be disturbed. This technique also helps to detect the food available for the reptilian and amphibian species such as beetles, termites, spiders, scorpions *etc.* which are their preferred foods.

- ***Basking Behavior***

This method of watching or locating Crocodiles is the most suitable but it can be applied mostly in winter season. In winter the temperature of the water of river becomes very low. Due to cooler weather and cold water this cold blooded reptile (Crocodiles) avoid to live in water and so they come outside the lake for enjoying sunshine to keep them warm. Thus counting of crocodiles becomes very easy at particular area during this season. This method helps the observer for finding its range, population and status. This method was not applied in the present study.

- **Indirect Methods :**

  - **Information from different sources**

Information has been collected from game watchers, local fishermen, boatsmen (Mallas) and other local villagers of different goths.

- **Presence of signs like faecal pellets, tracks, den or tunnels (egg laying excavation)**

Evidences from the impression of finger or foot prints, or tail, presence of faecal pellets, tracks and existence of tunnels (egg laying excavation) help this method a lot, so for finding the existence, range and rough population of reptilian and amphibian fauna specially of Crocodile and snakes this method is very suitable.

2.5- ICHTHYOLOGICAL SURVEY

Survey Methodology:

1. **Fish Surveys**:

   There are five techniques for fish surveys viz., Bankside counts, trapping, cast netting, gill netting and electro fishing (Environment Impact Assessment Ordinance Guidance note no. 10/2004, Singhanouvong and Phouthavong, 2002). Bankside counts are only done on the banks of clear shallow streams, Trapping is done by using specific baits for specific species, Gill netting is only for commercial fishes while electro fishing is done only in wadable streams with limited width. The cast netting technique is, therefore, the most appropriate technique for large rivers and reservoirs while studying the fish biodiversity.

2. **Cast Netting Technique:**

   A general survey of the reservoir area was conducted to identify different habitats in the study area. Field stations were selected covering all the representative habitats of the study area. Long/Lat of all the field stations was noted to make it more accessible during the study period. Fish will be collected using cast nets of two different mesh sizes, (small one having mesh size of 1cmX1cm and having a circumference of 30 ft. and the large one with mesh size of 2.5cmX2.5cm and with a circumference of 45ft.) so that the fish fauna of all the age classes could be collected. Ten nets of each mesh size were casted in each stations along a line transect of about 500 meters. The collected material was numbered according to stations and the effort no. and mesh size. The fish specimens were preserved in 10% formaldehyde solution in the field.

   Large specimens were given an incision in the belly to ensure proper preservation. The specimens were identified in the laboratory and taxonomical checklists along with English and local names were compiled. The status of each species (common, rare, migratory, resident, fishery value, maximum size *etc.*) was determined on the basis of relative abundance of each species in the project area. The data on fish species collected in each station and of every habitat along with their long/lat. was available for developing GIS based information regarding occurrence and distribution of fish species in core and buffer zones.

   Any possible change to resident and migratory fish was anticipated on the bases of data collected, previous studies carried out in the area and on the basis of interviews of the fishermen and local people, agro forestry practices and irrigational pattern in the area and conservational measures that could be expected in future.

The fishes of special concern i.e., fishes of economic value and fishes of ecological concern were given special attention and were documented and enlisted on the basis of the first hand information collected by the actual data and the information already available through previous studies.

2.6- AVI-FAUNA SURVEY

Survey Methodology

1. **Point and transect count**
   Most point counts were conducted for areas such as sand banks where a moving transect was not possible since the open ground made birds unapproachable, or for areas where movement was restricted i.e. water-courses with low water level which restricted linear movement in a boat. Usually concentrations of birds or a particular species of interest was marked with a GPA waypoint. The transect count method was usually applied to habitat edges such as reed beds and the edge of mud-flats. At the beginning of the transect count the starting point was marked with a GPS as was the starting time. As transect proceeded along a physical feature, such as a reed bed, species were recorded as they were observed. The survey was conducted in September and December 2006 respectively.

2.7 – LIMNOLOGICAL STUDIES:

Survey Methodology

2.7.1-Water Quality:

The water samples were collected using Nikson bottles from the surface (approx.5cm), midpoint and at the bottom of the total depth. The samples were mixed in equal proportion (approx.1 litre) to make one composite sample. Sterilized plastic containers of 3 litre capacity were used. Temperature and salinity was note down at the spot. The following parameters were analyzed by given methods and equipments.

i. **Temperature:** Ordinary Thermometer was used for the temperature of water on the sampling site.

ii. **pH:** The pH of the samples was determined by using Orion pH meter.

iii. **Salinity**: Salinity was measured at the spot by Salinometer (Atago Company Ltd. 2441 S/Mill range b/w 0-100ppm).

iv. **Total Dissolved Solids and Total Suspended Solids:** These parameters were measured by *gravimetric method* as described in the Standard Methods for the Examination of Water and Wastewater (APHA, 1992).

v. **Bio-chemical Oxygen Demand: (BOD):** The test of BOD_5 was performed using *azide modification method* as described in Standard Methods for the Examination of Water and Wastewater (APHA, 1992).

vi. **Chemical Oxygen Demand: (COD):** The method used for the estimation was *dichromate reflux method* as reported in Standard Methods for the Examination of Water and Wastewater (APHA, 1992).

vii. **Nitrate:**Nitrate was estimated using *brucine sulphanilic acid method* as mentioned in
Standard Methods for the Examination of Water and Wastewater (APHA, 1992).

viii. **Phenol:**The estimation of Phenol was made by *distillation* followed by the addition of *potassium ferric cyanide* as per method reported in Standard Methods for the Examination of Water and Wastewater (APHA, 1992).

ix. **Oil and grease (N-hexane extract):** The pH of sample was made acidic using concentrated HCL and mixed thoroughly with n-hexane in shaking water bath. Hexane layer was separated in a separator funnel and collected in a pre weighed conical flask. Hexane was evaporated in a water bath at a temperature of 70^{O}C and oil and grease was estimated using *gravimetric method* as reported in Standard Methods for the Examination of Water and Wastewater (APHA, 1992).

x. **Cadmium and Chromium:** The Metal contents in the sample was measured with the help of A*tomic Absorption Spectrophotometer* (Pye Unicam, SP-2900) using standard techniques as mentioned in the Standard Methods for the Examination of Water and Wastewater (APHA, 1992).

xi. **Pesticide:**
High Pressure Liquid Chromatography (HPLC): The HPLC (Shimadzu, Japan) chromatographic system consisted of a solvent delivery pump LC-10AS, connected with an auto injector model SIL-6A and a reheodyne injection valve fitted with a sample loop (20μl). A guard column filled with μ Bondapak C_{18}.

xii. **Microbiological Analysis:** For bacteriological analysis the water samples were collected in pre-sterilized bottles, were transported to the laboratory in ice packed insulated containers for the following bacteriological analysis. It was done only for the Kinjhar Lake. 1) *Total Coliforms Count* (TCC), 2) *Total Faecal Coliforms Count* (TFC), 3) *Total Faecal Streptococci* (TFS).

The samples were processed in Laminar Flow hood using sterilized culture media by Most Probable Number (MPN) as per standard methods described in (American Public Health Association, 1998).

2.7.2 - Invertebrates

Survey Methodology:

During the field work altogether 5 stations on each three sites viz. Kinjhar Lake, Chotiari Reservoir and Keti Bunder were marked and samples of macro invertebrates and planktons were collected.

Physico-chemical parameters of water were also observed and collected for laboratory analysis. Motor boat was used for sample collection in three sites.

Procedures for sample collections and equipments used;

1) **Macro invertebrates:** Peterson grab was used to collect the sediment samples from various locations. Sterile plastic bottles of 500 ml were used and samples were preserved in 70% alcohol in field.
2) **Planktons (Zoo and Phyto):** were collected through plankton net. The net was towed from a motor boat travelling at a very slow speed. 250 ml of sterile plastic container were used for collection of samples and they were preserved with 10% formalin in the field.
3) **GPS:** Geographical coordinates were taken at each sampling point through Garmin 12, having 12 channels.

Transportation of samples:

The samples were brought to the laboratory immediately after collection and stored in the deep freezer for analysis and identification.

2.7.3- Laboratory Analysis and Identification Methods:

1- Kinjhar Lake and Chotiari Reservoir:

Total 30 samples, 10 of phytoplankton, 10 for zooplankton and 10 samples of sediment mud for Macro invertebrates (5 each from Kinjhar Lake and 5 from Chotiari reservoir) were brought in the laboratory for the analysis and identification up to the species level.

Phytoplankton
Station wise phytoplankton samples were filtered in nanoplankton net (mesh size30 µm), the identification was carried out with the help of taxonomic keys and illustrations by Desikachary (1959) and Prescott (1962). The photography of the species was done at magnification ×400 with the help of DCM 35 (350 pixels) digital camera under the binocular microscope (Swift M.3300D). Identification of the specimens was done with temporary mount of 2-4% glycerin and iodine solution at glass slides.

Zooplankton
Taxonomic identification of zooplankton was carried out with the help of taxonomic keys (Battish, 1992; Pennak, 2001: Ward and Whipple 1959). Photographs of the specimens were made by fitted camera with magnification of ×45, ×100 and ×400 under the binocular microscope (Nikon Eclipse E200). The enumeration of the zooplankton was done with counting tray at magnification ×45 & ×100 under the binocular microscope (KYOWA Opt. model SDZ-TR-PL). Identification of the specimens was done with temporary mount of 50% glycerin in cavity slides.

Macro- invertebrates (Benthos)
Macro- invertebrates samples were filtered with the help of a Set of Sieves, residues were identified with the help of taxonomic keys.

2- Keti Bunder:

Phytoplankton and Zooplankton:

Total 15 samples, 5 of phytoplankton, 5 for zooplankton and 5 samples of sediment mud for Macro invertebrates from Keti Bunder were brought in the laboratory for the analysis and identification.

For counting and identification up to major taxonomic groups the samples were well stirred for uniform distribution and three replicates of 2 ml from each samples were obtained. The phytoplankton and zooplankton were counted and identified up to the major taxonomic group and percent distribution is expressed as individual per m^3.

- ***Meiobenthos and Macrobenthos Analysis:***
  - ***Extraction of Meiofauna:*** Meiobenthos (Greek *meio* meaning smaller) are small, ubiquitous organisms operationally defined as organisms passing through 0.5 or 1 mm mesh sieve, but retained on 63 mm mesh. 20 g of sediment were sieved through 63 mm the retained sediments were washed into sorting bottles where upon gentle agitation fauna were suspended, water was decanted and thus fauna were separated from heavy sandy sediment. This agitation and decantation process was repeated 3-4 times depending on when sediments were found devoid of fauna. The samples were counted by taking three replicates of 1ml and identified up to major taxonomic groups.
  - ***Extraction of Macrofauna:*** The sediment samples were sieved from 1 mm mesh size sieve to extract the macrofauna, the macrofauna retained on the sieve were backwashed and preserved for identification and counting.

Statistical Analysis

For Kinjhar Lake and Chotiari Reservoir:

1) Relative Abundance %:

The relative abundance % of phyto and zooplankton were calculated as;

$$R.A = \frac{\#\text{ of individuals}}{\text{Total }\#\text{ of individuals}} \times 100$$

2) Diversity Index:

Diversity Index was calculated by using following formula:

$$\text{Diversity Index (H)} = \frac{S - 1}{\text{In } N} \quad \text{(Boyd, 1981)}$$

Where;
S= The number of genera of Phyto or Zooplanktons
N= The total number of Phyto or Zooplanktons
In-= Natural logarithm.

For Keti Bunder:

❖ **Median (Md)**

Median is calculated from 50th percentile of frequency distribution.

❖ **Diversity index.**

The most frequently used ones are Simpson's index (Simpson, 1949) and several that are based on the Shannon function (Shannon and Weaver, 1949). The Shannon function is given by

$\boxed{\mathbf{H=\sum (ni/N)*(\log ni/N)}}$

Where ni= The number of individuals in the *i*th species.
N=The total number of individuals in all the species.
Log Commonly chosen logarithm base are 10 (Pielou, 1977).

❖ **Equatibility.**

Equitability can be measured in several ways.

$\boxed{H_{max}= -S\ (1/s \log_2 1/s) = S}$

Where
H_{max} =Species diversity under conditions of maximal equitability
S=Number of species in the community.
Equbality can be defined as the ratio.

$E=H/H_{max}$
Where E= Equtability (range 0-1).
H= Observed species diversity.
H_{max} = Maximum species diversity= $\log_2 S$.

❖ **Species richness.**

The number of species is the oldest concept of species diversity and is called Species richness. (Krebs, C. J. 1978). Species richness was expressed simply as the number of species S and also calculated in accordance with Margalef (1975) as

$\boxed{D" =(S-1) \log N.}$

SECTION 3

FINDINGS

3.1- Keti Bunder

3.1.1 Natural Vegetation Assessment

FINDINGS OF THE NATURAL VEGETATION SURVEY

3.1.1.1 Phyto-sociological Studies of Keti Bunder

Transect: 1

Site: Dadi Bhachal Coordinates: 24°9'24.4"N 67°26'28.4"E
Soil Type & condition: Mud flat
Grazing Conditions: None DMY: 24.3 kg /ha
Plant Community: *Aeluropus - Avicennia*

Vegetation at mud flat near Dadi Bhachal

This area is situated near Keti Bunder at a place where there is a tomb called Dadi Bhachal. According to local people, the tomb used to exist on inland area far away from main sea. However, due to sea intrusion, it came into creeks with the passage of time. Now this tomb with numerous coloured flags on it, can be seen from far away place while approaching to Keti Bunder from sea thus serving as a light house for the fisher men. Vegetation generally grows on mud flats situated inside small creeks. Vegetation consisted of small shrubby plants of *Avicennia marina, Arthrocnemum macrostachyum* and a grass called *Aeluropus lagopoides.* The plant community was named after *Aeluropus - Avicennia* based on their Importance value and SDR.

Table 4: Phytosociological Parameters of T1 at Keti Bunder

Species	No.	R.C. %	R. F. %	R.D. %	I.V.	SDR
A.marina	15	56.20	23.68	33.33	113.21	37.74
Aeluropus lagopoides	186	37.18	68.42	33.33	138.93	46.31
Arthrocnemum indicum	11	6.63	7.89	33.33	47.86	15.95

Transect: 2

Site: Sital Coordinates: 24° 11' 17.8" N 67°25'39.3"E
Soil Type & condition: Mud flat
Grazing Conditions: Over grazing DMY: 688.8 kg /ha
Plant Community: *Aeluropus lagopoides*

This site exists along a creek that leads ultimately to a big creek called Chann. The site got its name after a Hindu businessman named Seetal who used to live here long ago. No tree was found here except small and scattered plants of *Avicennia marina.* The ground was covered with rhizomatous grass of *Aeluropus lagopoides* that formed the plant community also. Over grazing by cattle was also apparent.

A.marina bushes are dotted on the md flat

Table 5: Phytosociological Parameters of T2 at Keti Bunder

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
A.marina	2	2.06	4.00	33.33	39.39	13.13
Aeluropus lagopoides	623	97.94	96.00	66.67	260.61	86.87

Transect 3:

Site: Phirt Coordinates: 24° 08'18.1"N 67°24'04.2"E

Soil Type: Mud Flat Grazing Intensity: Moderate Grazing

Plant Community: *Aeluropus* DMY: 100.3 kg/ha

The site is occupied by *Aeluropus lagopoides,*

This point was also located on mud flat in between small creeks leading to Chann Creek. Vegetation over here consisted of only three species viz., *Aelurupus lagopoides, Avicennia marina and Arthrocnemum macrostachyum.* In terms of Importance value and SDR the plant community was named after *Aeluropus lagopoides*.

Table 6: Phytosociological Parameters of T3 at Keti Bunder

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Aeluropus lagopoides	168	80.94	87.50	33.33	201.77	67.26
Arthrocnemum macrostachyum	8	14.47	5.00	33.33	52.80	17.60
Avicennia marina	16	4.60	7.50	33.33	45.43	15.14

Transect No: 4

Site: Hajamro Creek Coordinates: 24°07'54.4"N 67°25'02.9"E

Soil Type: Mud Flat Grazing Intensity: No Grazing

Plant Community: *Aeluropus* DMY: 21.8 kg/ha

Hajamro creek leads to the deep sea. Blatter et al., 1929 reported that in Hajamro River (creek) they found *Aeluropis villosus (Aeluropus lagopoides)* grass and eight species of mangroves namely *Rhizophora mucronata, Rhizophora conjugate, Ceriops candolleana, Ceriops roxburghiana, Bruguiera gymnorhiza, Sonneratia acida, Aegiceras majus and Avicennia officinalis*. Unfortunately today we find only one species of mangroves, *i.e., Avicennia marina* and that is also in juvenile stage. Authors also reported dense forests of *Populus euphratica* and *Acacia farnesiana* in Hajamro creek which are absolutely absent now.

This site was also dominated by *Aeluropus lagopoides*

This creek is densely populated. There are large and small human habitations all along the creek even up to the large sea. Ironically, in spite of sparse cover and juvenile stage of mangroves, there is a lot of regeneration of *A. marina* on almost each and every mud flat. This shows that still there is lot of potential of rehabilitation of mangroves if serious efforts are carried out. The location was covered only by two species, *i.e*., *Aeluropus lagopoides and Arthrocnemum macrostachyum.*

Table 7: Phytosociological Parameters of T4 at Keti Bunder

Species	No	R. C. %	R.F. %	R.D %	I.V.	SDR
Aeluropus lagopoides	202	60.81	83.33	66.67	210.81	70.27
Arthrocnemum macrostachyum	12	39.19	16.67	33.33	89.19	29.73

Transect No: 5

Site: Khobar Coordinates: 24°00'49.8"N 67°27'21.0"E

Soil Type: Mud Flat Grazing Intensity: Grazing

Plant Community: *Cynodon-Aeluropus* DMY: 50.04 kg/ha

This point is situated very near to the point where Indus River falls into the sea. This area was having sweet underground water due to river inflow. It was a strange scene that right at the edge of sea one can find fresh water. Main plant species over here consisted of *Cynodon dactylon*, *Aeluropus lagopoides, Arthrocnemum macrostachyum and Sporobolus virginicus*

The site is occupied by *Aeluropus lagopoides,*

Table 8: Phytosociological Parameters of T5 at Keti Bunder

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Aeluropus lagopoides	401	44.51	40.00	33.33	117.84	39.28
Arthrocnemum indicum	8	4.91	3.64	16.67	25.21	8.40
Cynodon dactylon	264	47.18	39.09	33.33	119.60	39.87
Sporobolus virginicus	42	3.41	17.27	16.67	37.34	12.45

Transect No: 6

Site: Coordinates: 24°06'09.0"N 67°25'41.2"E

Soil Type: Mud Flat Grazing Intensity: Over Grazing

Plant Community: *Aeluropus* DMY: 219.4 kg/ha

This point is situated in a sub-creek of main Hajamro creek. Near to this point is a thick patch of mangroves left so far. Local people informed that this patch of mangroves is left deliberately to feed camels. Transect site was located on a mud flat on left side of the channel. Natural vegetation was mainly comprised of *Aeluropus lagopoides* interspersed with *Arthrocnemum macrostachyum.*
There was sparse regeneration of

Avicennia marina that showed that potential of mangrove recovery still exists.

This site was occupied by *Aeluropus lagopoides* interspersed with *Arthrocnemum macrostachyum*

Table 9: Phytosociological Parameters of T6 at Keti Bunder

Species	No	R.F. %	R.F. %	R.D %	I.V.	SDR
Aeluropus lagopoides	178	77.21	82.86	50.00	210.07	70.02
Arthrocnemum macrostachyum	6	22.79	17.14	50.00	89.93	29.98

Transect No: 7

Site: Mehar Sheikh Coordinates: 24°12’14.4”N 67°33’25.3”E

Soil Type: Saline-sodic Grazing Intensity: Over Grazing

Plant Community: *Suaeda*
DMY: 178.62 kg/ha

This is an inland area situated about 4 – 6 km from Keti Bunder town towards Gharry. Soil over here is saline sodic and comprised of species like *Aeluropus lagopoides, Arthrocnemum macrostachyum, Tamarix passernioides, Tamarix alii, Pentatropis nivalis, Suaeda fruticosa, Cressa cretica, Cyperus sp., and Halocne Halostachys belangerana.*

This location is situated along road side surrounded all around by agricultural fields. Crops growing in this area are Banana, Beetle leaf and fodder. Grazing conditions looked very intense.

Table 10: Phytosociological Parameters of T7 at Keti Bunder

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Aeluropus lagopoides	18	5.37	23.26	16.67	45.29	15.10
Arthrocnemum macrostachyum	4	33.84	9.30	16.67	59.80	19.93
Pentatropis nivalis	2	8.89	4.65	16.67	30.20	10.07
Suaeda fruticosa	68	40.71	58.14	16.67	115.52	38.51
Tamarix passernioides	1	0.65	2.33	16.67	19.64	6.55
Tamarix alii	1	10.54	2.33	16.67	29.53	9.84

Table 11: Summary of Plant Communities**,** *Associated species and forage production in Keti Bunder*

Transect #	Site Name	Coordinates	Plant Community	Vegetation type and dominant species	Soil Type	DMY (Kg/ha)	Grazing condition
T-1		24°9'24.4"N 67°26'28.4"E	*Aeluropus – Avicennia*	*Avicennia marina, Arthrocnemum macrostachyum and Aeluropus lagopoides*.	Mud flat	24.3	None
T-2		24° 11' 17.8" N 67°25'39.3"E	*Aeluropus lagopoides*	*Avicennia marina, Aeluropus lagopoides*	Mud flat	688.8	Over grazed
T-3	Phirt	24° 08'18.1"N 67°24'04.2"E	*Aeluropus lagopoides*	*Aeluropus lagopoides, Avicennia marina and Arthrocnemum macrostachyum*	Mud flat	100.3	Moderate
T-4	Hajamro Creek	24°07'54.4"N 67°25'02.9"E	*Aeluropus lagopoides*	*Aeluropus lagopoides and Arthrocnemum macrostachyum.*	Mud flat	21.8	No Grazing
T5	Khobar	24°00'49.8"N 67°27'21.0"E	*Cynodon-Aeluropis*	Cynodon dactylon, *Aeluropus lagopoides, Arthrocnemum macrostachyum and Sporobolus virginicus*	River bank	50.04	Moderate
T6		24°06'09.0"N 67°25'41.2"E	*Aeluropus lagopoides*	*Aeluropus lagopoides, Arthrocnemum macrostachyum.*	Mud flat	219.4	Over Grazing
T7	Mehar Sheikh	24°12'14.4"N 67°33'25.3"E	*Suaeda fruticosa*	*Aeluropus lagopoides, Arthrocnemum macrostachyum, Tamarix passernioides, Tamarix alii, Pentatropis nivalis, Suaeda fruticosa, Cressa cretica, Cyperus sp., and Halocnemum strobilac Halostachys belangerana.*	Saline - sodic	178.62	Over Grazing

3.1.1.2 Summary of Keti Bunder Flora

Vegetation assessment of Keti Bunder was carried out from 16th to 18th September, 2006. Some 39 plant species belonging to 32 genera and 19 families are identified. Of them, 5 grasses (Poaceae family) have been identified. The major plant families which contributed in the formation of vegetation in the area in question are Chenopodiaceae (17.95%) and Poaceae (12.82%) followed by Amaranthaceae (7.69%), Aizoaceae (7.69%), Tamaricaceae (7.69%), Papilionaceae (5.13%), Boraginaceae (5.13%), Tiliaceae (5.13%) and Zygophyllaceae (5.13%). The alphabetical checklist of species along their family, vernacular names and life form/habit is provided (Table 12).

Figure 1: Contribution of plant families to overall Flora of Keti Bunder

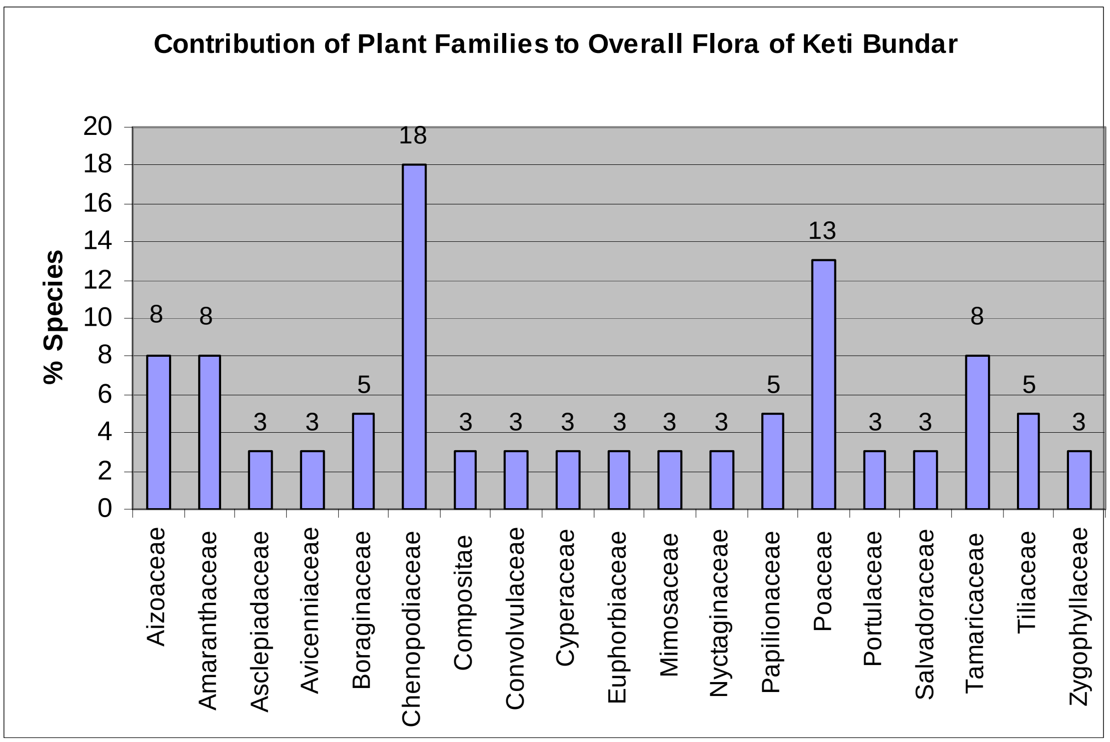


Table 12: Plant species recorded at Keti Bunder

S.No.	Family	Plant species	Life form	Habit
1.	Aizoaceae	*Trianthema crystallina* (Forsk) Vahl	Therophyte	Herb
2.	Aizoaceae	*Trianthema portulacastrum* L.	Therophyte	Herb
3.	Aizoaceae	*Zaleya pentandra* (L.) Jeffery	Chamaephyte	Herb
4.	Amaranthaceae	*Achyranthes aspera* L.	Chamaephyte	Shrub
5.	Amaranthaceae	*Amaranthus viridis* L.	Therophyte	Herb
6.	Amaranthaceae	*Digera muricata* (L.) Mart.	Therophyte	Herb
7.	Asclepiadaceae	*Pentatropis nivalis* (J.F.Gmel.) Field & J.R.I.Wood	Phanerophyte	Climber
8.	Avicenniaceae	*Avicennia marina* (Forssk.) Vierh.	Phanerophyte	Tree
9.	Boraginaceae	*Heliotopium ophioglossum* Boiss	Chamaephyte	Herb
10.	Boraginaceae	*Heliotropium curassavicum* L.	Chamaephyte	Herb
11.	Chenopodiaceae	*Arthrocnemum macrostachyum* (Moric.)C.Koch	Chamaephyte	Shrub
12.	Chenopodiaceae	*Chenopodium album* L.	Therophyte	Herb
13.	Chenopodiaceae	*Chenopodium murale* L.	Therophyte	Herb
14.	Chenopodiaceae	*Halostachys belangerana* (Moq.)Botsch.	Chamaephyte	Shrub
15.	Chenopodiaceae	*Salsola imbricata* Forsk.	Phanerophyte	Shrub
16.	Chenopodiaceae	*Suaeda fruticosa* Forsk. ex J.F.Gmelin	Phanerophyte	Shrub
17.	Chenopodiaceae	*Suaeda monoica* Forsk. ex J.F.Gmelin	Phanerophyte	Shrub
18.	Compositae	*Launaea procumbens* (Roxb.) Amin	Chamaephyte	Herb
19.	Convolvulaceae	*Cressa cretica* L.	Chaemophyte	Herb
20.	Cyperaceae	*Cyperus rotundus* L.	Cryptophyte	Sedge
21.	Euphorbiaceae	*Euphorbia granulata* Forsk.	Therophyte	Herb
22.	Mimosaceae	*Prosopis juliflora* DC.	Phanerophyte	Shrub
23.	Nyctaginaceae	*Commicarpus boissieri* (Heimerl) Cufod.	Phanerophyte	Herb/subshrub
24.	Papilionaceae	*Argyrolobium roseum* (Camb.) J. & S.	Therophyte	Herb
25.	Papilionaceae	*Melilotus indica* (L.) All.	Therophyte	Herb
26.	Poaceae	*Aeluropus lagopoides* (L.) Trin. ex Thw.	Haemicryptophyte	Herbaceous Grass
27.	Poaceae	*Chloris barbata* Sw.	Haemicryptophyte	Grass

S.No.	Family	*Plant species*	Life form	Habit
28.	Poaceae	*Cynodon dactylon* (L.) Pers.	Haemicryptophyte	Grass
29.	Poaceae	*Dactyloctenium scindicum* Boiss. *Oryza coarctata* Roxb.	Haemicryptophyte Cryptophyte	Grass Grass
30.	Poaceae	*Sporobolus virginicus* (L.) Kunth	Cryptophyte	Grass
31.	Portulacaceae	*Portulaca oleracea* L.	Therophyte	Herb
32.	Salvadoraceae	*Salvadora persica* L.	Phanerophyte	Tree
33.	Tamaricaceae	*Tamarix alii* Qaiser *Tamarix kermanensis* Baum	Phanerophyte Phanerophyte	Tree Tree
34.	Tamaricaceae	*Tamarix pakistanica* Qaiser	Phanerophyte	Tree
35.	Tamaricaceae	*Tamarix passernioides* Del. ex Desv.	Phanerophyte	Tree
36.	Tiliaceae	*Corchorus depressus* (L.) Stocks	Chamaephyte	Herb
37.	Tiliaceae	*Corchorus trilocularis* L.	Therophyte	Herb
38.	Zygophyllaceae	*Fagonia indica* Burm.f.	Chamaephyte	Herb
39.	Zygophyllaceae	*Zygophyllum propinquum* Decne.	Chamaephyte	Herb

Table 13: Carrying Capacity of Keti Bunder Transect Sites

Transect No.	Total Dry Matter Forage Kg/ha	Available Forage (Kg/ha)	A.U
1	24.3	14.8	2.12
2	688	412.8	58.97
3	100.3	60.18	8.6
4	21.8	13.08	1.87
5	50.04	30.024	4.23
6	219.4	131.64	18.81
7	178.62	107.17	15.31

3.1.1.3 Two Ways Indicator Species Analysis (TWINSPAN)

Cover data from transects of each of three sites (Keti Bunder, Kinjhar, Chotiari) were compiled using spreadsheet programme Microsoft® Excel®. These values ware then analyzed using software "*Two Ways Indicator Species Analysis (TWINSPAN*)" as mentioned earlier in Materials & Methods section*.* The results of the analysis for each of the three above-mentioned sites are described as under.

Table 14: TWINSPAN Analysis - Keti Bunder

	Transects						
Species	**2**	**4**	**6**	**1**	**3**	**5**	
1 Aeluropus lagopoides	5	5	5	3	4	5	0
2 Arthrocnemum indicum	-	4	4	1	2	2	0
5 Pentatropis nivalis	-	-	-	-	1	-	0
4 Cynodon dactylon	-	-	-	-	-	5	1
6 Sporobolus virginicus	-	-	-	-	-	2	1
	0	0	0	0	0	1	
	0	0	0	1	1		

Community: *Aeluropus – Arthrocnemum*.

This plant community was found on 6 out of a total seven transects. Mostly these transects which comprised this community were mud flats scattered over all creeks surveyed during this field exercise. The dominant species of this community was *Aeluropus lagopoides* followed by *Arthrocnemu indicum.* Although there are a total of 39 plant species recorded over a total of 07 transects, yet community was formed by the two species, mentioned earlier. Both of these species; *Aeluropus lagopoides* followed by *Arthrocnemu indicum* are halophytes belonging to families Poaceae and Chenopodiaceae and having life-forms of Haemicryptophyte and Chamaephyte, respectively.

3.1.1.4 Biodiversity Index & Species Richness:

I. **Diversity** (*i.e*., the species richness and species diversity within each locality). With reference to species richness, Kinjhar Lake surroundings have shown the highest α-diversity with a total of 41 plant families, 104 genera and 136 species, followed by Chotiari with 40 families, 82 genera, and 116 species, Pai forest with 27 families, 51 genera, and 64 species; and Keti Bunder with 19 families, 32 genera and 39 species.

   Among various families, Gramineae exhibited the highest species richness in Kinjhar, Chotiari, and Pai; whereas in Keti Bunder Chenopodiaceae showed the highest diversity followed by Gramineae. This is indicative of the high salinity of the Keti Bunder area. Besides Chenopodiaceae, other halophytes/salt tolerant species include *Avicennia marina, Aeluropus lagopoides, Sporobolus virginicus* and three species of *Tamarix.*

II. **β-Diversity** (*i.e*., the species turnover from one locality to other locality or diversity between localities)

Localities were compared in pairs with every possible combination. The highest number of species was shared by Kinjhar and Chotiari, *i.e*., these two localities had 57 species in common, followed by Chotiari – Pai with 30 species in common, Kinjhar-Pai with 30 species in common, Kinjhar-Keti with 27 species in common, and Keti-Chotiari with 13 species in common, and Keti-Pai with 12 species in common.

These localities pairs showed similarity index likewise.

Table 15: Similarity Index and β-diversity of study sites

Localities pairs	Similarity index (CC)	*β-diversity
1. Keti-Kinjhar	0.308	1.691
2. Keti-Chotiari	0.168	1.832
3. Keti-Pai	0.233	1.767
4. Kinjhar-Chotiari	0.452	1.548
5. Kinjhar-Pai	0.30	1.700
6. Chotiari-Pai	0.333	1.667

* Inversely proportional to similarity index.

Only 8 species were found to be shared by all localities, among which the notorious alien species *Prosopis juliflora* was most prominent.

III. **γ-Diversity** (*i.e*., diversity of all localities collectively).

The total number of species of all the four localities came to be 241. However, this number is liable to increase in future with more detailed surveys in different parts of the year.

3.1.1.5 Significant findings:

Sporobolus virginicus: This species was previously recorded from inland localities in the Flora of Pakistan. In the present survey, we have recorded it for the first time from intertidal mudflats in Hajamro creek, Khobar creek and Kharo Chhan.

3.1.2 Large Mammals Assessment

FINDINGS OF MAMMALIAN FAUNA SURVEY:

The mammalian fauna of Keti Bunder can be divided into two distinct groups *i.e*. Marine Mammal and Terrestrial Mammal. They are being analyzed here separately:

3.1.2.1 Marine Mammals:

The creeks in Keti Bunder are a part of the North Arabian Sea and lies within the Indian Ocean Sanctuary, set up by the International Whaling Commission to protect cetacean population. Information on marine cetaceans along Pakistan coast is very sparse and very little data has been published. Ahmed & Ghalib (1975) reported occurrence of nine species. Roberts (1997) lists thirteen species of marine cetaceans (whale, dolphin and porpoise) from coastal waters of Pakistan, based on information on stranding of different species along the coast and personal communication with different people on sightings of various species. Further evidence suggests that there is an undocumented high diversity of cetaceans in Pakistani waters. There has been no comprehensive survey of cetaceans in Pakistan and only recently University Marine Biological Station (UMBS), University of London, Millport, U.K. in partnership with WWF – P and Centre of Excellence in Marine Biology (CEMB), University of Karachi started cetacean surveys on Pakistan coast and offshore with support from Darwin Initiative and WWF – P is undertaking surveys of dolphins and porpoise in Korangi – Phitti creek system in Karachi with support from the Ocean Park Conservation Foundation.

Situation Analysis:

The comprehensive survey of cetaceans in creeks in Keti Bunder is yet to be undertaken. Boat based survey in Chann and Hajmaro creek was conducted. Though no cetacean was sighted during survey on 17th September 2006 but evidences of its occurrence in the creek have been collected. A skeleton of dolphin was collected from an island in Chann creek. However, three Hump backed Dolphin *(Sousa chinensis)* was sighted in Richal creek near Chann on 29th November 2006. Although, the whales do not enter into creeks but the dolphins and porpoise are sighted in creeks and at the mouth of Indus. Personal communication with the local fishermen and showing them sketches of small cetaceans during this brief survey confirms the presence of following species in the creek waters:

ORDER: CETACEA
FAMILY: DELPHINIDAE

- Bottlenose dolphin *Tursiops truncatus*
- Hump-backed dolphin *Sousa chinensis*
- Common dolphin *Delphinus delphis*
- Spinner dolphin *Stenella longirostris*

FAMILY: PHOCOENIDAE

- Finless Porpoise *Neophocaena phocaenoides*

The Finless Porpoise is listed in Appendix I of the CITES.

The locals call all the dolphins as “Malhar” and Porpoise as “Taapi”. Though their numbers have declined as compared to two decades earlier but they are frequently seen here (*Pers. Comm.* Local fishermen). The fishers have misconception of dolphins being fish rather than mammalian. The fishers do not deliberately catch the cetaceans but when they find the dead specimen, they use its flesh as fish bait or use the oil for rasping on boat. The further loss of cetacean population in the area would not only be a loss in the biodiversity but also a resource that could be used for ecotourism. The cetacean can be exploited for ecotourism thus providing an opportunity that could support the local community for livelihood.



All cetacean species are listed as Endangered in IUCN Red list. The small cetaceans could be regarded as indicator species of the health of marine ecosystem.

3.1.2.2 Terrestrial Mammals

The habitat types available at Keti Bunder are agricultural field, canal, mangrove forest, estuaries, orchards and bushes of *Salvadora, Sueda and Phragmites* in some areas. No study on terrestrial mammals has been undertaken in the area. Roberts (1997), Ahmad and Ghalib (1978) have worked on the distribution and status of mammals in Pakistan but they did not mention particular occurrence in Keti Bunder area. Ahmad *et al* (1988) worked on the vertebrate fauna of mangrove swamps of Sindh and recorded 5 species of mammals, including marine and terrestrial mammal but they did not describe the mammals occurring exclusively in the nearby terrestrial area of mangrove forests.

Situation Analysis:

Only three species of large mammals, belonging to 2 Orders and 3 Families were recorded from the area, as given in Table 16:

Table 16: List of Large Mammals recorded at Keti Bunder

S.#	Order	Family	Scientific Name	English Name	Urdu Name	Sindhi Name
1	Artiodactyla	Bovidae	*Sus scrofa*	Wild Boar	Jangli Suar	
2	Carnivora	Canidae	*Canis aureus*	Asiatic Jackal	Geedar	Giddarr
3		Felidae	*Felis viverrina*	Fishing Cat		Mash Billi, Mach Bagral

Additionally, following species of small mammals were also observed.

- Porcupine *(Hystrix indica)*

3.1.2.4 Summary Of Individual Species:

A summary of the individual species recorded from Keti Bunder area is given hereunder:

1. **Wild Boar (Sus scrofa) –** is a common ungulate not only through out the country but in Keti Bunder area also. It lives in marshes and swamps protected by rich growth of reeds and scrub in the area. Wild boar is a gregarious species living in small groups. It is a nocturnal animal, coming out of its hiding place at dusk to feed. It is mainly herbivorous so its presence was located at night near agricultural fields and banana farms. The animal causes destruction to crops and fruit plants and uproots more plants than it consumes. It digs the ground with its snout for foraging thus damaging tracts of cultivation in the area.

   The animal has no threat as it is considered an unclean animal in the area and the locals hate its presence. The animal is not protected and is persecuted by the agriculturist. Its persecution is also not easy as it is a strong animal and can only be shot down. Its presence was found in about 5% of the sites sampled.

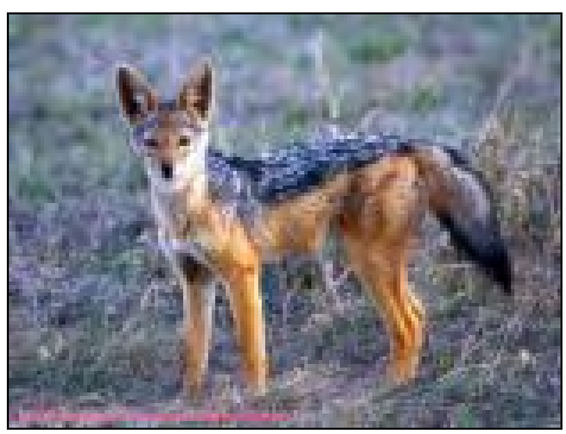


Photo Source: http://images.google.com

2. **Jackal *(Canis aureus)* -** is a common mammalian species found in the area. The jackal is a medium sized carnivore with doglike features and a bushy tail. The population at Keti Bunder is located in all habitat types; in mangrove forest, in open lands with small bushes, thickets and they even visit near human settlements. They undertake most of their activities at night time. Their calls at night are prominent. The estimates

of the population could only be made after the comprehensive survey.

In 20% of sites sampled, its presence was confirmed and calls of 10 animals were recorded.
They often prey upon the poultry so the people mainly the poultry farm owners dislike this animal. But in general the attitude of people towards this animal is ignorance. The jackal was used to be trapped and killed during early 1970s for trade of its skin. Since the government has banned export of animals and its derivatives so pressure of hunting this animal has reduced. Even then, according to locals, the jackal population in the area has reduced because now they get less fish for food and change in land use practices as many areas have been converted into agricultural fields and orchards.

3. **Fishing Cat *(Felis viverrina)* –** Fishing cat mainly feeds upon fish along the coast and canal banks. They even catch fish by putting head into water. However, they are seldom seen in open areas during day time. It prefers living in the area where they can hide during day time. The *Lai, Salvadora, Khabbar* bushes present near water points are their favorable hiding places. In 5% of the sites sampled, its presence was confirmed.

Photo Source.
http://images.googl.com

One fishing cat was sighted on the edge of water (Coordinate 24°11' and 67°32'). Fishing cats in the area was used to be killed or trapped in 1970s and early 80s when trade on cat's fur was allowed, but its demand has declined since the ban on export has been imposed by the Federal Government. The IUCN lists fishing cat as 'Vulnerable' species. The species is listed as Vulnerable in IUCN Red list and Appendix II of CITES. The species is 'Protected' under Sindh Wildlife Protection Ordinance 1972.

Medium Sized Mammals

Besides the above mentioned large and medium sized mammals, the following mammalian species was also recorded.

1. **Porcupine *(Hystrix indica)* –** One dead specimen of porcupine was collected from an orchard. It is common in the area since its quills were found frequently near the agricultural land and fruit farms.

3.1.3 Small Mammals Survey

FINDINGS OF THE SMALL MAMMALS STUDY:

3.1.3.1 HABITAT DESCRIPTION:

The coastal areas of Sindh are regularly inundated by the salt water of the Arabian sea. Moreover, the reduced water of the Indus has rendered this area as a barren salty waste land. The small mammals are therefore not abundant in the areas affected by the advancing seas. Area of 5-10 km along the coast does not have a rich diversity of small mammals. The area beyond this limit is used for agriculture especially for the banana gardens, waste land with shrubby outgrowth, Agricultural fields, human settlements, canal banks, riverine forests and riparian areas with diverse habitats. These areas are full of small mammals and the most dominant species are *Tatera indica, Rattus ratus, Suncus murinus*, mongooses, bats, Indian civit, house mouse and Sindh rice rat. This area is full of snakes as they get plenty of food in the form of rodents. The species Rattus rattus, Sindh rice rat and Tatera indica are serious crop pests and they are really abundant in these areas.

3.1.3.1 Biological Information of the Key Species:

1. *Tatera indica* (Indian Gerbil)

Biology:

It is the most abundant rodent in the drier areas of Pakistan. It is also the most abundant species in the Chotiari reservoir area. It is a burrowing rodent and has occupied all the flat areas with deep soil in the agricultural fields, along the reservoir banks and in the desert. It is commonly found in the alluvial banks of the agricultural fields and lives in big colonies. It is the most aggressive animal knocking out the other sympatric species like *Gerbillus nanus*. It also has a close associated with the *Meriones* species in the desert part of the area.

Behaviour:

It lives in the open areas in shallow burrows with wide holes made usually on the banks of the agricultural fields. During winter season they mainly occupy open areas and shift to close-by shady areas and bushes during the summer season. The species, *gerbillus nanus* which is sympatric to this species, is knocked out from the open areas to the bushes during the winter season but in the open areas during the summer season.

Habitat requirements:

Alluvial and deep soil usually surrounded by patches of bushes.

Breeding season:

This is highly prolific species and breeds through out the year in the hot environment of the area. There is, however, a bi-modal peak of breeding activity during the spring and monsoon season. Litter size varies from 1-9 with an average of five.

Feed requirements:
It is an omnivorous species eating insects, beetles, grains and leaves of trees but the seeds of crops dominate in their diet.

Distribution in Study Area
The species *Tatera indica* is one of the most common species in the Chotiari area. As it is the burrowing rodent so it is represented in compact alluvial deep soils and agriculture-desert interface areas, stable sand dunes and Woody areas with hard soils where burrowing is possible.

Distribution in Pakistan:
It is found in plain areas of Sindh and Punjab and Chaghi, Kharan, Pungur and Mekran areas of Balochistan.

Distribution in the World:
It is found in drier regions of India and Sri Lanka. On the western side of Pakistan, it is found in Afghanistan, Iran, Iraq and Syria.

Abundance:
It is one of the most abundant species in the Nara desert.

Significance of the Species:
It is one of the most abundant species in the area. Being a big sized species, it plays an important role in the food chain of any ecosystem. It serves as a food item for mongooses, foxes, cats, rat snakes and cobras.

Status:
Population of this species is quite high in the flat areas and inter-dunal compact areas of desert. It is the most ecologically adaptable species and can intrude in other neighboring areas.

Threats/ Impact assessment:
No any threat can be envisaged to this species in the well area.

4- *Bandicota bengalensis* (Indian Mole rat)

Biology:
It is a medium sized rat with semi-naked scaly tail slightly shorter than head and body length. The body fur is hard and coarse and the belly dark Grey. There are four digits on the fore-feet and five digits on the hind feet each bearing a strong claw. The incisors are very broad and smooth on the interior surface without any longitudinal grooves.

Behavior:
The rodent is an active and powerful digger and excavates extensive burrow systems. It is mostly nocturnal and does not tolerate other animal in the same burrow. It stores food grains underground and breeds very rapidly. It is considered a serious agricultural pest. They are not gregarious and are extremely aggressive rodents.

Habitat requirements:
It needs mesic conditions with damp soil for burrowing and prefers embankments around cultivated fields. It avoids sand dune areas or dry rocky regions.

Breeding season:
The bandicoot breeds throughout the year and females bear large litters. Largest litters rae recorded from September to November when 14-18 young per litter were common. During rest of the year, 5-10 young are produced. It is found that sixty nine young per year are produced by a single female.

Feed requirements:
The principal food of this rodent is rice, succulent shoots of the rice plants, tubers of the grass, seeds of sorghum and millet.

Distribution:
It is found in Sindh, northern and eastern Punjab, parts of Hazara division, Abbotabad, and Peshawar. Outside Pakistan, it is found in India, Sri Lanka, Nepal, Burma, Malaysia and Indonesia.

Abundance:
It is very common species in the cultivated areas and the inter-face areas of the Chotiari reservoir.

Significance of the Species:
It is the most active and successful species in the cultivated areas of Sindh and Punjab. It is serious agriculture pest and also plays a role in ecosystem as food for the carnivorous species.

Table 17: Checklist of the Small Mammals found in the Keti Bunder Areas

Sr.#	Species	Common Name	Data Source
1	*Tatera indica*	Indian Gerbil	Trapped
2	*Bendicota bengalensis*	Sindh Rice Rat	Trapped
3	*Mus musculus*	House mouse	Trapped
4	*Rattus rattus*	House Rat	Trapped
5	*Golunda ellioti*	Bush rat	Trapped
6	*Suncus murinus*	House shrew	Trapped
7	*Hystrix indica*	Indian crested porcupine	Trapped
8	*Funambulus pennantii*	Norther palm Squirrel	Trapped

9	*Lepus nigricolis*	Indian hare	Trapped
10	*Herpestes edwardsi*	Indian Grey Mongoose	Trapped
11	*Herpestes javanicus*	Small Asian Mongoose	Trapped
12	*Vivericula indica*	Small Indian Civit	Secondary data
13	*Pipistrellus kuhlii*	Kuhls' bat	Secondary data
14	*Rhinopoma microphyllum*	Large rat tailed bat	Trapped
15	*Paraechinus micropus*	Indian hedge hog	Trapped

3.1.4 Reptilian Study

FINDINGS OF THE REPTILIAN STUDY:

The first survey was done at Jhaloo area at Haji Allah Dino Shah Goth, Keti Bunder. During the survey there was a short meeting with the villagers, Mr. Ishaq Khan, Mr. Jan Ali Shah and Mr. Yakoob Shah to get some information regarding the occurrence of snakes, lizards, frogs and toads. This meeting was very important because they were very much interested and wished that some experts should come here and control the population of snakes. The whole area was surrounded by agricultural land in which 90% was Banana farm. The area was thickly covered by Banana trees in different farms. Besides this *Accacia, Tamarix, Prosopis, Calotropis* sp were also growing abundantly. So this habitat is very suitable for the breeding, shelter and occurrence of lizards and snakes. In banana farms, there is a very good population of species of small mammals such as mouse, mice, rats etc. All these mammals are good source of food for snakes and lizards. During conversation one of the villagers brought a dead non poisonous snake *Platyceps ventromaculatus* (Glossy Bellied Racer) and a 4 ft freshly dead cobra. *Naja oxiana* (Oxus Cobra). The cobra entered in his house at night from banana farm and was killed. Finally the whole area was surveyed by the method of "One hour plot searches". Two monitor lizards *Varanus bengalensis* (Indian Monitor) were seen moving actively around the study area. Five tracks of snakes were observed. Two *Calotes versicolor* (Indian Garden Lizard) were seen climbing on *Accacia* trees. The villagers of this Goth told that during the recent raining season, 22 people were bitten by snakes. Four of them died due to non – availability of Anti venom in the hospital so where ever and whenever they see snake they kill it. They were told that if you kill and finish the population of snakes, mouse, mice and rats will becomes a great problem for you. They will damage your crops and you will suffer a lot because snakes eat mouse, mice and rats and in this way control their population and save their crops in the farm and field. So if the snakes enter in their house you can kill but in the field let them go away. They will not harm you. They will hide in their shelter.

Similarly the area of the Goth Aman Sammo in the name of Sardar Aman Sammo of Keti Bunder was surveyed. A large freshly dead Porcupine was found on the road. This mammal is a pest and destroys agricultural crops so people kill them. The in and around the area of this Goth was surveyed. The area was flat and sandy – cum muddy beds with some *xerophytic* plants such as *Calotropis* and *Tamarix* sp. In this survey "One hour plot searches" method was applied for the determination of the population of Reptilian and Amphibian fauna. No doubt that this habitat is suitable for the snakes and lizards but except some dropping of lizards and two *Acanthodactylus cantoris* (Indian Fringe – Toed Sand Lizard) moving actively, no other lizards and snakes were seen. It was concluded that during the recent heavy rainfall of monsoon period many species of lizards and snakes have been washed away and the area became unstable for the population of Reptilian fauna. It will take time for the area to be stable for the population of the species. The situation will be observed and compared during the next survey. Tikka Goth area of Sardar Suleiman Gogo of Keti Bunder was also surveyed. There were fresh water small canal. Many frogs and toads *Euphlyctis cyanophlyctis* (Skittering Frog) and *Bufo stomaticus* (Marbled Toad) were seen actively floating in the water. The dry sandy – cum muddy flat area with some *xerophytic* plants such as *Tamarix, Calotropis. Accacia* species was studied. Here also Reptilian fauna has suffered much and lost their lives in flood of heavy rainfall. The population dynamics of the species will re established and will become stable in future.

Karochan area of Keti Bunder was also visited. Four Monitor Lizards, *Varanus bengalensis* (Indian Monitor Lizard) were seen moving actively in the field. The habitat is very suitable for Reptilian fauna and Amphibian fauna. Some where there were small pools of fresh water where many frogs and toads, *Euphlyctis cyanophlyctis* (Skittering Frog) and *Bufo stomaticus* (Marbled Toad) were seen floating actively. Tracks of non – poisonous snakes, lizards (Geckos) and (Agamas) were seen. Two *Trapelus agilis* (Brilliant Agama) and three *Acanthodactylus cantoris* (Indian Fringe – Toed Sand Lizard) were seen moving actively. Photographs were taken for record.

Table 18: Checklist of Reptilian and Amphibian Fauna of Keti Bunder

REPTILES

S. No.	Family	Species	English Name	Local Name	Status
1.	Agamidae	*Calotes versicolor versicolor*	Indian Garden Lizard	Girgit or Girgitan, Shyee, Kafir Girgit	Common
2.		*Trapelus agilis agilis*	Brilliant Agama	Karrun	Common
3.		*Trapelus megalonyx*	Afghan Ground Agama	Karrun	Common
4.	Gekkonidae	*Cyrtopodion kachhensis kachhensis*	Warty Rock Gecko	Chuggul	Common
5.		*Cyrtopodion scaber*	Keeled Rock Gecko	Chuggul	Common
6.		*Hemidactylus brookii…*	Spotted Indian House Gecko	Chhipkali, Chiplee, Chuttee	Common
7.		*Hemidactylus flaviviridis*	Yellow-Bellied House Gecko	Chhipkali, Chiplee, Chuttee	Common
8.		*Hemidactylus leschenaultii*	Bark Gecko	Chhipkali, Chiplee, Chuttee	Common
9.	Lacertidae	*Acanthodactylus cantoris*	Indian Fringe-Toed Sand Lizard	Chhipkali, Chiplee, Chuttee	Common
10.	Uromastycidae	*Uromastyx hardwickii*	Indian Spiny-tailed Lizard	Sandha, Sonder	Appendix II in CITES. Common in Pakistan

11.	Varanidae	Varanus bengalensis	Indian Monitor	Goh or Goh-Pard	Appendix I in CITES, Common
12.	Colubridae	*Platyceps ventromaculatus ventromaculatus*	Glossy-bellied Racer	Sagi, Jhari wala Saanp	Common
13.		*Psammophis condanarus*	Indian Sand snake	Tormar or Thormar	Less Common
14.		*Ptyas mucosus*	Dhaman or Rope Snake	Dhaman	Common
15.		*Spalerosophis diadema atriceps*	Royal Snake	Kourar	Common
16.	Elapidae	*Bungarus caeruleus caeruleus*	Indian or Common Krait	Sangchul, Pee – un	Common
17.		*Naja naja*	Indian Cobra or The Cobra	Kala Naag, Naagu, Chamcha Maar	Common
18.		*Naja oxiana*	Oxus Cobra or Brown Cobra	Kala Naag, Naagu, Chamcha Maar	Endangered, included in Red Data List
19.	Viperidae	*Daboia russelii russelii*	Russel's Viper or Chain Viper	Koriala, Khuppar	Common
20.		*Echis carinatus sochureki*	Eastern or Sochurek's Saw-scaled Viper	Loondee, Jalebi, Khuppar	Common
21.	Trionychidae	Lissemys punctata	Indian Flap-shell Turtle	Kachwa	Less Common, Appendix I in CITES

AMPHIBIANS

S. No.	Family	Species	English Name	Local Name	Status
1.	Ranidae	Euphlyctis cyanophlyctis cyanophlyctis	Skittering Frog	Daddu	Common
2..	Bufonidae	Bufo stomaticus	Marbled Toad	Daddu	Common

Naja oxiana **(Oxus cobra or Brown cobra)**

3.1.5 Ichthyological Survey

FINDINGS OF THE FISH SURVEY:

Status of Palla Fisheries in coastal areas:

The famous prized Palla fish, Tenualosa ilisha, has migratory habits and for breeding ascends upstream in the river Indus from the Arabian Sea (Jafri and Melvin, 1988). A Sizeable volume of literature is available regarding migratory behaviour of this fish (Kulkarni, 1950; Pillay, 1963; Jhingran, 1982). 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 (Ghulam Muhammad 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. It was reported as single large species of fish comprising 70% of the total catch in the past. Presently it hardly constitutes 15 % of the total catch. The decline in the catch of this fish can be visualized from the table and graph below.

The decline in fish catch is persistent despite an increase in the number of fishermen involved in fishing, increase in fishing boats, and an overall increase in the duration of fishing efforts. Similarly the yearly variation in shrimp catch shows a large drop in catch per trawler. The average catch has dropped from 300 tones per years in 80s' to 20 tones in 2000.
During the survey 63 species of fin fishes (Table 18) and 24 species of shell fishes were recorded (Table 19).

Table 19: Annual catch of the Palla fish, Tenualosa ilisha in coastal areas, Sindh, Pakistan.

Year	Fish catch (metric tones)
1980	1,859
1985	928
1987	707
1988	590
1989	403
1990	400
1991	402
1992	390
1993	310
1994	298
1995	265
1996	269
1997	272
1998	251
1999	222
200	190
2001	170

(Source: Fisheries Directorate Sindh and Development Statistics of Sindh)

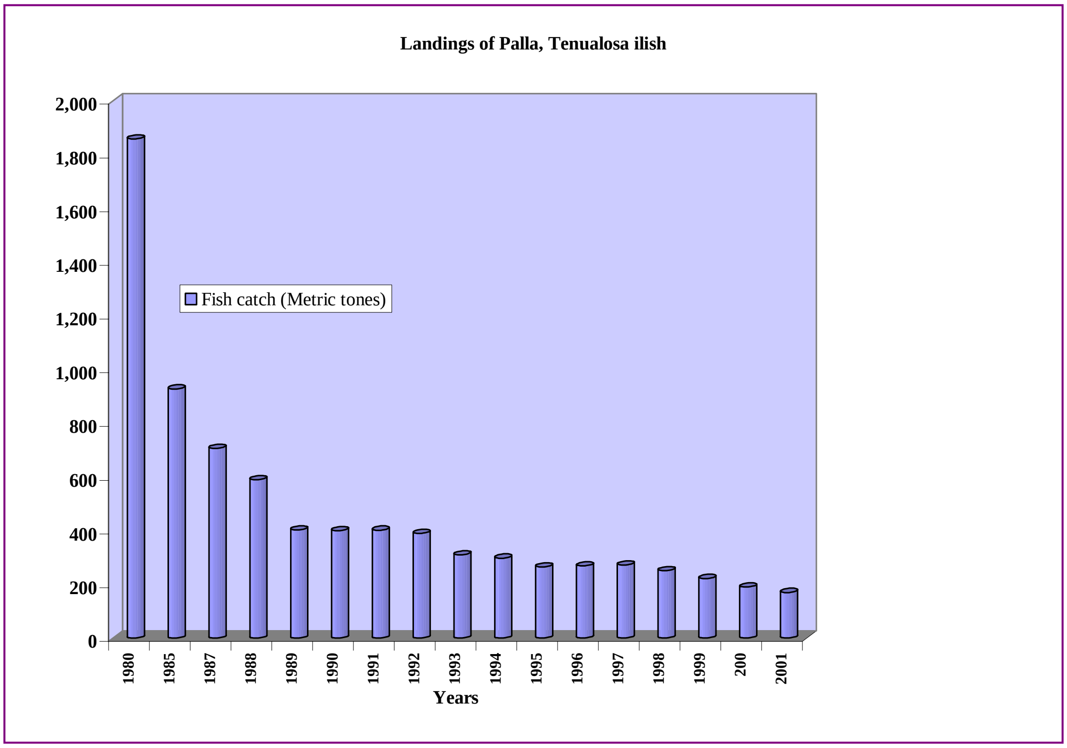


Figure 2: Landing of Palla Tenualosa Ilisha

Table 20: List of Fin fish species recorded from Keti Bunder Area

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
1	*Elops machnata*	Elopidae	Tenpounder	Kinarhal	90	10,000	Average	-	Inhabits shallow coastal waters, estuaries and bays	Small fishes, mollusks, shrimps, crabs
2	*Albula vulpes*	Albulidae	Bonefish, ladyfish	Viaat	100	7,000	Average	0 - 84	Inhabits shallow coastal waters, estuaries and bays	mollusks, shrimps, crabs
3	*Arius maculates*	Ariidae	Spotted catfish	Khagga	40cm	50	low	2-10	Inshore and estuarine water	Invertebrate and small fishes
4	Hyporamphus (Hyporamphus) limbatus	Hemiramphidae	Congaturi halfbeak	Thute	22	40	Average	1-2 (Epipelagic)	Marine and brackish water	omnivorous
5	*Strongylura leiura*	Belonidae	Banded needlefish	Kangho	100	200	Average	1-2 (pelagic)	Coastal waters, estuaries as well as freshwaters	Small fishes
6	*Pseudorhombus arsius*	Bothidae	Largetoothed flounder	Kuker-jeeb	35	1000	high	1-100	Esturine Continental shelf	Bottom living animals
7	*Alepes djedaba*	Carangidae	Shrimp scad	Seem, Bangra	40	90	Average	3-10	Coastal water and reef areas (Amphidromous)	Crustacean and copepods
8	*Carangoides chrysophrys*	Carangidae	Longnose trevally	Seem, Bangra	72	500	Average	30 - 60	Open waters of coastal reefs	Crustacean, copepods
9	*Caranx para*	Carangidae	Banded scad	Bangra, Kakkar	20	500	low	2-10	Inshore coastal	zooplankton
10	*Scomberoides commersonnianus*	Carangidae	Blacktip leatherskin	Aal, Saram	120	16,000	high	10-200	Coastal waters	Fish, crustacean
11	*Rastrelliger chrysozonus*	Scombridae	Indian mackerel	Bangra	35	120	high	2-10	Coastal water	Fish and shrimp larvae

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
12	*Scomberromorus guttatus*	Scombridae	Indo-Pacific king mackerel	Kalgund	76	800	high	8-200	Coastal to deeper water	Fishes and cephalopods
13	*Trachinotus blochii*	Carangidae	Snubnose Pompano	Sonab	110	3,400	high	0-7	Juveniles in shallow sandy or muddy bays near river mouths	Molluscs and crabs
14	*Chirocentrus dorab*	Chirocentridae	Dorab wolf herring	Kerli, gairi	100	500	Average	0-120	Pelagic, inshore	Small fishes and crustaceans
15	Nematolosa nasus	Clupeidaae	Long-ray bony bream	Daddi-palli	22	200	Average	-	Pelagic, coastal waters, entering estuaries, creeks	Detritus, phyto and zooplankton
16	Escualosa thoracata	Clupeidae	White sardine	Mithoo	10	15	low	-	Pelagic in coastal waters	Phytoplamkton and Zooplankton(copepods, crabs, bivalve larvae, fish eggs
17	Anodontostoma chacunda	Clupeidae	Shortnose Gizzard Shad	Daddi-palli	17	150	low	-	Pelagic, in inshore waters	Detritus, phyto and zooplankton
18	Ilisha megaloptera	Clupeidae	Bigeye ilisha	Palli	28	200	low	-	Pelagic in coastal waters	Fish and crustacean
19	Ilisha melastoma	Clupeidae	Indian ilisha	Palli	12	70	low	-	Pelagic in coastal waters	Mollusc
20	*Opisthopterus tardoore*	Clupeidae	Tardoore		20	90	low	-	pelagic; amphidromous	Small crustacean and

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
										zooplankton
21	*Tenualosa ilisha*	Clupeidae	Hilsa shad	Palla	60	2,490g	high	0-200	pelagic; anadromous	plankton, mainly by filtering, but apparently also by grubbing **on** muddy bottom
22	*Cynoglossus dubius*	Cynoglossidae	Tonguesoles	sole	50	300	high	-	Continental shelf	bottom-living invertebrates
23	*Cynoglossus bilineatus*	Cynoglossidae	Tonguesoles	sole	44	225	high	10 - 400	Coastal areas and estuaries. May ascend into the freshwater	bottom-living invertebrates
24	Thryssa hamiltonii	Engraulidae	Thryssa	Phyasa	20	40	low	-	Pelagic in coastal waters, estuaries	mainly **on** crustaceans (zoea larvae, amphipods, Acetes)
25	Thryssa setirostris	Engraulidae	Thryssa	phyasa	15	40	low	-	Pelagic in coastal waters, estuaries	mainly **on** crustaceans (zoea larvae, amphipods, Acetes)
26	*Coilia dussumieri*	Engraulidae	Anchovy	Patia	20	15	low	0 - 50	Pelagic; Amphidromous	copepods, prawn and fish larvae
27	Gerres filamentosus	Gerreidae	Long-rayed silver-biddy	Jerkari	25	125	low	1-50	Shallow coastal waters	crustaceans, polychaetes and forams on sand or muddy-sand

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
										bottoms
29	*Gerres oyena*	Gerreidae	Lined silver-biddy	Jerkari	30.	125	low	0-20	coast, saltwater lagoons, and estuaries	crustaceans, polychaetes and forams on sand or muddy-sand bottoms
30	*Periophthalmus koelreuteri*	Gobiidae	Mud skipper	-	10	40	low	-	Coastal areas	small fish,crabs and other arthropods
31	Glossogobius giuris	Gobiidae		-		40	low	-	-	small insects, crustaceans and small fish
32	Pomadasys kaakan	Haemulidae	Grunter	Dhother	80	35000	high	1-60	Coastal waters	benthic invertebrates and small fishes
33	*Pomadasys stridens*	Haemulidae	striped grunter	Bukra	20	15000	high	65 - 68	coastal waters	benthic invertebrates and small fishes
34	*Lates calcarifer*	Latidae	Baramundi	Dangri	200	60,000	high	10 -40	demersal; catadromous	crustaceans, molluscs, and smaller fishes
35	*Leiognathus daura*	Leiognathidae	Goldstripe Ponyfish	Kaanteri	14	30	low	0-40	Shallow waters	polychaetes, bivalves, small crustaceans and sponges

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
36	*Leiognathus splendens*	Leiognathidae	Splendid ponyfish	Kaanteri	17	40	low	10 - 100 m	coastal waters	fish , crustaceans , foraminiferans , and bivalves
37	*Secutor insidiator*	Leiognathidae		Kaanteri	11.3	25	low	10 - 150	shallow waters	zooplankton including copepods, mysids, and larval fishes and crustaceans
38	*Lutjanus johnii*	Lutjanidae	One spot golden snapper	Hira	35	40000	high	-	Shallow coastal waters mainly around mangroves	fishes and benthic invertebrates including shrimps, crabs and cephalopods
39	*Liza subviridis*	Mugilidae	Green back mullet	Chhodi	30	500	high	-	Coastal waters, estuaries	small algae, diatoms and benthic detrital material taken in with sand and mud
40	*Liza melinoptera*	Mugilidae	Large scale gery Mullet	Boi, Mori	22	30	low	-	Coastal waters, Estuaries	**Feeds on** plant detritus, microalgae, minute benthic organisms, and organic

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
										matter in sand and mud
40	*Liza carinata*	Mugilidae	Keeled mullet	Boi, Mori	25	40	Average	-	Marine coastal waters	small benthic invertebrates , planktonic organism alga and detritus
41	*Liza parsia*	Mugilidae	Gold spot mullet	Boi, Parsi	16	30	low	-	Shallow coastal waters	small benthic invertebrates , planktonic organism alga and detritus
42	*Mugil cephalus*	Mugilidae	Large scale mullet	Pharra, Boi	60	12,000	high	0 - 120	Coastal areas ,enters estuaries and rivers	Omnivorous zooplankton, benthic organisms and detritus
43	*Valamugil cunnesius*	Mugilidae	Long arm mullet	Pharra, Boi	50	1000	high		Coastal waters, estuaries, enters rivers	organic matter contained in sand and mud
44	*Upeneus vittatus*	Mullidae	Yellow-striped goatfish	Manori	28	300	Average	1-100	Turbid waters	small crustaceans
45	*Congresox talabonoides*	Muraenesocidae	Pike congers	Bam	250	50000	Average		Continental shelf	**Feeds** at night, **on** bottom fishes and crustaceans

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
46	Platycephalus indicus	Platycephalidae	Bartail flathead	Kuker	100	3000	High			crustaceans and small fish
47	*Grammoplites suppositus*	Platycephalidae	Softfiin flathead	Kuker	25	300	Average	1-75	Rocky shores	crustaceans and small fish
48	*Polynemus indicus*	Polynemidae	Indian threadfin	Seeri, Ranwas	200	80000	High	-	Shallow coastal waters	omnivorous and **feeds on** diatoms, copepoda, crustaceans and smaller fish
49	*Scatophagus argus*	Scatophagidae	Spoted scat	Korgi	38	2000	Average	1 - 4	Inhabit brackish estuaries and the lower reaches of freshwater	worms, crustaceans, insects and plant matter
50	*Protonibea diacan*	Sciaenidae	Jewfish	Sua	120	60000	High	0-60	Coastal waters	crustaceans and small demersal fishes
51	*Johnius dussumieri*	Sciaenidae	Silver Jewfish	Mushka	30	40	Average	1-40	coastal waters. Enters estuaries	invertebrates and small fishes
52	*Otolithes ruber*	Sciaenidae	Rosy jewfish	Mushka	90	7,000	High	10 - 40	Coastal waters	fishes , prawns and other invertebrates
53	*Promicrops lanceolatus*	Serranidae	Grouper	Gisser	270	400,000	High	1 -300	-	fishes, large crustaceans and **...** Chelonia

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
										mydas
54	*Sillago sihama*	Sillaginidae	Silver whiting	Bhambore	25	40	High	-	Shores, Bays, Creeks, estuaries	mainly on polychaetes and other benthic organisms
55	*Solea elongata*	Soleidaae	Solea	Phani	30	30	low	-	Shallow coastal waters	benthic invertebrates, especially small crustaceans
56	*Acanthopagrus berda*	Sparidae	Black Bream	Dandya	50	1,500	High	1-50	Muddy grounds in estuarine areas	invertebrates, including worms, mollusks, crustaceans and echinoderms
57	*Acanthopagrus latus*	Sparidae	-	-	50	1,500	High	0-50	coastal waters, estuaries, river mouth	echinoderms, worms, crustaceans and mollusks.
58	*Sphyraena putnamiae*	Sphyraenidae	Barracuda	Kund	90	40000	High	1-100	inshore-pelagic	fishes and large invertebrates
59	*Eleutheronema tetradactylum*	Polynemidae	Four finger threadfin	Seeri, Ranwas	200	80000	High		Shallow coastal waters entering river mouths	prawns and fish
60	*Pampus argenteus*	Stromateidae	Silver pomfret	Achopito, Sufaid poplet	60	30000	High	5 - 110	Inshore species	ctenophores, salps, medusae, and other

Sr.#	Species	Family	English name	Local name	Max Size (cm)	Weight (Grms)	Commercial value	Depth (M)	Habitat	Feeding habits
										zooplankton groups
61	*Terapon jerbua*	Teraponidae	Jerbua terapon	Ginghra	36	10000	Average	20 -290	Vicinity of river mouths, Estuarine, demersal; catadromous	Omnivorous, **feeds** upon fishes, insects, benthic invertebrates, and algae
62	*Terapon puta*	Teraponidae	Smallscale terapon	Ginghra	15	25	low	-	-	small fishes and invertebrates
63	*Lepturacanthus savala*	Trichiuridae	Hairtail	Talwar	120	3000	high	1-100	Benthopelagic	variety of small fishes and crustaceans

Table 21: List of Shell fish species recorded from Keti Bunder Area

Sr. No	Scientific name	Common English name	Local name	Max. Length	Commercial value
1	Penaeus indicus	White shrimp	Jaira	18-23	High
2	Penaeus marguiensis	White shrimp	Jaira	20-24	High
3	Penaeus mondon	Tiger shrimp	Kalri	27-34	High
4	Penaeus penicilatus	White shrimp	Jaira	16-21	High
5	Penaeus canaliculatus	Shrimp	Kalri	15-18	High
6	Penaeus semisulcatus	Shrimp	Kalri	18-23	High
7	Solenocera crassicornis	Shrimp	Kalri	9-14	Medium
8	Penaeus japonicus	Shrimp	Kalri	20-24	High
9	Parapenaaepsis stylifera	Shrimp	Kiddi	12-15	High
10	Parapenaaepsis hardwickii	Shrimp	Kiddi	11-14	Medium
11	Parapenaaepsis sculptilis	Shrimp	Kiddi	11-17	High
12	Metapaenaeus affinis	Shrimp	Kalri	15-19	High
13	Metapaenaeus mutates	Shrimp	Kalri	11-13	Medium
14	Metapaenaeus brevicornis	Shrimp	Jaira	10-13	Medium
15	Metapaenaeus monoceros	Shrimp	Kalri	15-20	High
16	Metapaenaeus stebbingi	Shrimp	Kalri	11-14	Medium
17	Scylla serrata	Mud crab	Kekra	20	High
18	Matula lunaris	Crab	Kekra	8-10	Low
19	Matula planipes	Crab	Kekra	7-10	Low
20	Charybdis feriata	Crab	Kekra	16	High
21	Portunus pelagicus	Blue Crab	Kekra	20	High
22	Portunus sanguinolentus	Crab	Kekra	18	High
23	Penulirus polyphagus	Lobster	-	-	-
24	Marcia cor	Clam	-	-	-

3.1.6 Avi Fauna Survey

FINDINGS OF THE AVI FAUNA SURVEY:

During the two surveys conducted in September and December 2006 respectively, a total of 69 species of birds was observed. There were 25 resident species and 44 migratory species observed in around the environs of Keti Bunder.

Table 22: List of Birds recorded from Keti Bunder.

	Name	*Scientific name*	Population range 1st visit	Population range 2nd visit	Status
1	White Pelican	*Pelicanus onocrotalus*	0	<10	Migrant
2	Little grebe	*Tachybaptus ruficollis*	<10	<10	Resident
3	Large Cormorant	*Phalcrocorax carbo*	0	10-50	Migrant
4	Little Cormorant	*Phalacrocorax niger*	<10	100-150	Resident
5	Marsh Sandpiper	*Tringa stagnatilis*	<10	50-100	Migrant
6	Common sandpiper	*Actitis macularia*	10-50	50-100	Migrant
7	Little stint	*Calidris minuta*	400-450	4500-5000	Migrant
8	Little ringed plover	*Charadrius dubius*	200-250	10-50	Migrant
9	Lesser Sand plover	*Charadrius mongolus*	300-350	500-1000	Migrant
10	Ringed plover	*Charadrius hiaticula*	500-550	1000-1500	Migrant
11	Greater Sand Plover	*Charadrius leschenaultii*	0	100-150	Migrant
12	Dunlin	*Calidris alpina*	350-300	2000-2500	Migrant
13	Broad billed Sandpiper	*Limicola falcinellus*	50-100	0	Migrant
14	Curlew Sand piper	*Calidris ferruginea*	100-150	1000-1500	Migrant
15	Terek Sandpiper	*Xenus cinereus*	<10	10-50	Migrant
16	Green sandpiper	*Tringa ochropus*	<10	0	Migrant
17	Green Shank	*Tringa nebularia*	<10	0	Migrant
18	Red Shank	*Tringa totanus*	500-1000	500-1000	Migrant
19	Whimbrel	*Numenius phaeopus*	10-50	10-50	Migrant
20	Curlew	*Numenius arquata*	10-50	10-50	Migrant
21	Little Tern	*Sterna albifrons*	50-100	300-350	Resident
22	Ruff	*Philomachus pugnax*	0	10-50	Migrant
23	Sanderling	*Calidris alba*	0	350-400	Migrant
24	River Tern	*Sterna aurantia*	<50	50-100	Resident
25	Red Shank	*Tringa totanus*	50-100	0	Migrant
26	Marsh Harrier	*Circus aeruginosus*	<10	0	Migrant
27	Common Sallow	*Hirundo rustica*	50-100	300-350	Resident
28	Sand Martin	*Riparia riparia*	50-100	0	Resident
29	Purple Heron	*Ardea purpurea*	<10	<10	Resident
30	Grey Heron	*Ardea cinerea*	10-50	<10	Migrant
31	Reef Heron	*Egretta gularis*	10-50	50-100	Resident
32	Cattle Egret	*Bubulcus ibis*	10-50	50-100	Resident

33	Intermediate Egret	*Egretta intermedia*	0	0	Migrant
34	Little Egret	*Egretta garzetta*	10-50	10-50	Resident
35	Pond Heron	*Ardeola grayii*	10-50	100-150	Resident
36	Glossy Ibis	*Plegadis falcinellus*	10-50	0	Resident
37	Black Winged Stilt	*Himantopus himantopus*	10-50	0	Resident
38	Lapwing	*Vanellus indicus*	10-50	0	Resident
39	Yellow Wagtail	*Motacilla flava*	10-50	0	Migrant
40	Yellow Headed Wagtail	*Motacilla citreola*	<10	0	Migrant
41	White Wagtail	*Motacilla alba*	10-50		Migrant
42	Eurasian King Fisher	*Alcedo atthis*	<50	<10	Resident
43	White Breasted King Fisher	*Halcyon smyrnensis*	<10	<10	Resident
44	Pied King Fisher	*Ceryle rudis*	10-50	<10	Resident
45	Black Belly Tern	*Sterna acuticauda*	10-50	0	Migrant
46	Whiskered Tern	*Chlidonias hybrida*	10-50	10-50	Migrant
47	Sandwich Tern	*Sterna sandvicensis*	0	10-50	Migrant
48	Common Tern	*Sterna hirundo*	10-50	50-100	Migrant
49	Lesser Crested Tern	*Sterna bengalensis*	10-50	0	Migrant
50	Gull Billed Tern	*Gelochelidon nilotica*	10-50	0	Migrant
51	Caspian Tern	*Sterna caspia*	0	<10	Migrant
52	Black Headed Gull	*Larus ridibundus*	10-50	50-100	Migrant
53	Brown Headed Gull	*Larus brunnicephalus*	0	<10	Migrant
54	Herring Gull	*Larus argentatus*	<10	0	Migrant
55	Great Black Backed Gull	*Larus marinus*	<10	0	Migrant
56	Oystercatcher	*Haematopus ostralegus*	<10	10-50	Migrant
57	Glossy Ibis	*Plegadis falcinellus*	0	10-50	Migrant
58	Grey Plover	*Pluvialis squatarola*	0	<10	Migrant
59	Crab Plover	*Dromas ardeola*	0	<10	Migrant
60	Black winged Stilt	*Himantopus himantopus*	0	50-100	Resident
61	Bar Tailed Godwit	*Limosa lapponica*	0	10-50	Migrant
62	Black Tailed Godwit	*Limosa limosa*	0	<10	Migrant
63	Crested Lark	*Galerida cristata*	n/a	n/a	Resident
64	Sand Lark	*Calandrella raytal*	n/a	n/a	Resident
65	House Crow	*Corvus splendens*	n/a	n/a	Resident
66	Bee eater	*Merops orientalis*	n/a	n/a	Resident
67	White-cheeked bulbul	*Pycnonotus leucogenys*	n/a	n/a	Resident
68	Red-vented bulbul	*Pycnonotus cafer*	n/a	n/a	Resident
69	Common Buzzard	*Buteo buteo*	n/a	n/a	Resident

3.1.6.1 Discussion:

The area of the Keti Bunder is composed of small and large creeks with scattered mangrove forest and huge seasonal mudflats some of which are covered with grass There majority of the species observed were water birds. It was estimated that the total bird population within the Keti Bunder area was about 13,000 individuals which was not as high as could be expected. The relatively low numbers could be due to unfavorable feeding and habitat conditions such as extreme low tidal time where the low tidal water exposes the muddy ground, soil of which was very soft which is not favorable for birds to feed or roost. Secondly the majorities of the mud flats with covered with thick carpets of grass species. This grass also rendered mud flats unsuitable to waders who could not move freely. Within the whole area there were very few habitats that were observed to be suitable for water birds and subsequently moderate populations were observed in these area.

Images 1 and 2: Mud flats showing the grass *Oryza sp.* at Keti Bunder

Dalmatian pelican was not observed during this survey though it was recorded from the Keti Bunder by the staff of Sindh Wildlife Department .The crab plover was not seen from any other site except from the Keti Bunder.

Image 3: Fresh water ecosystem, canals, fresh water/brackish water marshes also existed at Keti Bunder which are potentially supporting water birds

3.1.7 Limnological Study

FINDINGS OF THE LIMNOLOGICAL STUDY:

3.1.7.1 Water sample analysis:

The survey was conducted in the November 2006. Salinity recorded between 27.6 – 27.85 ppm, pH between 7.0 -7.5, Total Dissolved Solids ranged between 264-268 mg/L, Total Suspended Solids ranged between 840-1150 mg/L, Biochemical Oxygen Demand between 86-100 mg/L, Chemical Oxygen Demand between 157-177 mg/L, Phenol values ranged between 0.025-0.027 mg/L, Nitrate between 0.46-0.89 mg /L, Cadmium found nil in the sample while Chromium between 0.021-0.032 mg/L. Oil and Grease value obtained as 230 mg/L (Table 22).

Table 23: Physical Chemical parameter analysis at Keti Bunder:

Parameters mg/L	Sampling Stations					NEQS (Rev)
Physical parameters	ST-1 Hajamro Creek	ST-2 Hajamro Creek	ST-3 Khobar Creek	ST-4 Khobar Creek	ST-5 Chaan Creek	
pH	7.1	7.4	7..2	7.5	7.0	6-9
Temperature ^{o}C	25.50	26.10	25.80	26.00	26.60	40 ^{o}C=<3 ^{o}C
Salinity $^{0}/_{00}$	27.85	27.6	27.7	27.85	27.7	
Total dissolved solids (TDS)	268	265	264	266	266	3500
Total suspended solids (TSS)	922	840	1150	842	950	200
Chemical parameters						
Biochemical oxygen demand (BOD_5)	97	92	100	89	86	80
Chemical oxygen demand (COD)	158	162	167	157	177	400
Phenol	0.025	0.027	ND	ND	ND	0.3
Nitrate	0.46	0.89	0.74	0.63	0.57	50
Cadmium	Nil	Nil	ND	ND	ND	0.1
Chromium	0.032	0.021	ND	ND	ND	1.0
Oil and grease (n-Hexane extract)	230	ND	ND	ND	ND	10

3.1.7.2 Pesticide analysis:

Commercially used *pesticide* results depicted as negative for Malathione, Cypermetherine, Aldrin and Dialdrin for three sites *viz*, Kinjhar Lake, Chotirai reservoir and Keti Bunder (Table 22 A). But the further analyses were done and positive results were obtained for the following pesticides at 3 sites which were Acetempride at Keti Bunder and Chotiari Reservoir whereas Myalin was detected at Keti Bunder (Table 22B, Annexure 6).

Table 23 A: Pesticide analysis:

Sampling Site	Pesticide µg/L (BDL)			
	Malathione	Cypermetherine	Aldrin	Dialdrin
Keenjhar lake	-ve	-ve	-ve	-ve
Keti Bunder	-ve	-ve	-ve	-ve
Chotiari Reservoir	-ve	-ve	-ve	-ve

Table 23 B: Pesticide analysis:

Sampling Site	Pesticide µg/L (BDL)		
	Acetempride	Acetempride	Myaline
Keenjhar lake	-ve	-ve	-ve
Keti Bunder	+ve	-ve	+ve
Chotiari Reservoir	-ve	+ve	-ve

+ =Present
- = Absent

3.1.7.3 Planktons:

- ***Phytoplankton distribution***

The phytoplanktons are the primary producers of the food chain of the marine ecosystem. The phytoplankton community mainly composed of 8 genera, of which diatoms (*Chaetoceros* sp., *Coscinodiscus* sp., *Rhizosolenia* sp and some concentric diatom sp.) formed the dominant group followed with dinoflagellates (*Goniaulax, Ceratium, Dinophysis*) and tintinids (Table 23,Figure 3).

Table 24: Checklist of Phytoplankton recorded at Keti Bunder:

Sampling Stations	Hajamro Creek	Hajamro Creek	Khobar Creek	Khobar Creek	Chaan Creek
Class Bacillariophyceae					
Coscinodiscus sp.	+	-	+	+	+
Concentric sp.	+	+	+	+	+
Rhizosolenia sp.	-	+	-	-	-
Chaetoceros sp.	+	+	+	+	+
Class Chrysomonadea Order Dinoflagellida					
Dinophysis acuta .	+	-	-	-	+
Goniaulax sp.	-	+	-	-	-
Ceratium sp.	+	-	-	+	+
Class Ciliata Order Tintinnida					
Tintinnopsis sp.	+	-	-	+	+

+ =Present
- = Absent

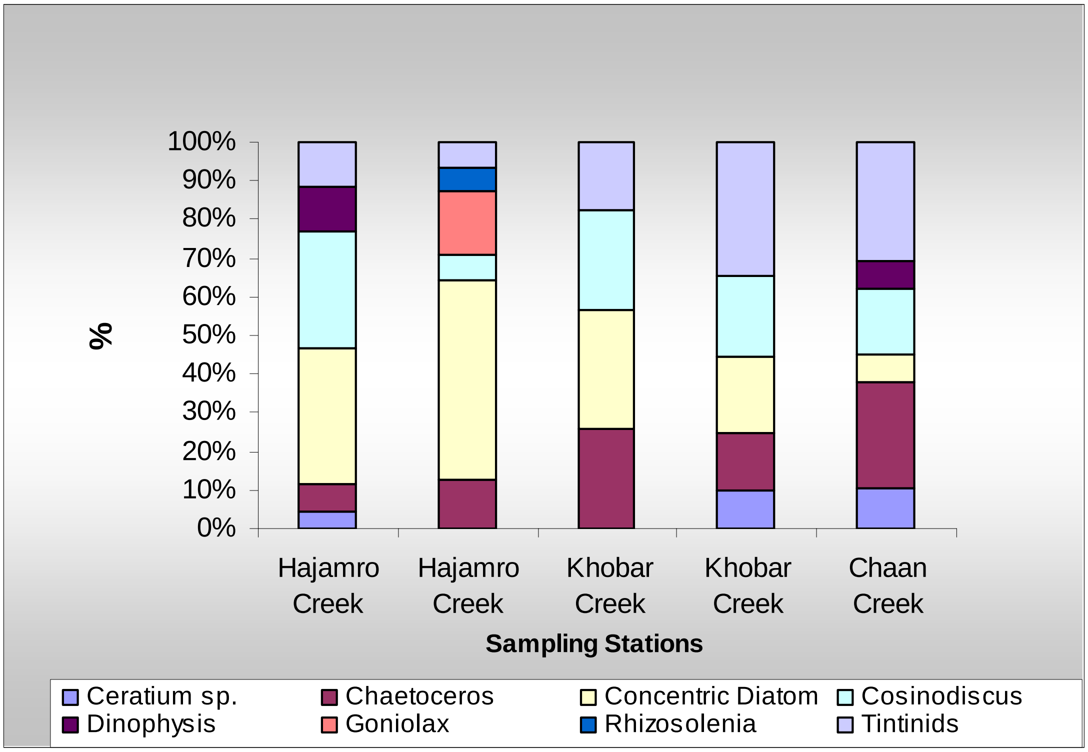


Figure 3: Distribution of Phytoplankton at Keti Bunder

- ***Zooplankton distribution:***

Zooplanktons play a key role in the pelagic food chains serving as the connecting link between primary producers and secondary consumers. Studies of the long-term fluctuations in the abundance of plankton organisms are therefore, important in relation to the conservation of marine resources. The zooplankton community was typically found to be composed of 20 groups, of which copepod, cypris larvae of barnacles, cladocerans, decapod and gastropod larvae were the conspicuous members of the family. Copepods dominated and formed the most important group of zooplanktons comprising 30 % (Hajamro Creek) to 75% (Khobar Creek) of the total zooplankton (Table 24, Figure 4).

Table 25: Checklist of Zooplankton at Keti Bunder:

Sampling Station	Hajamro Creek	Hajamro Creek	Khobar Creek	Khobar Creek	Chaan Creek
Phylum Ctenophora					
Ctenophores sp.	+	+	+	-	-
Phylum Chaetognatha					
Sagitta sp.	+	-	-	-	-
Phylum Annelida					
Polychaete larvae	-	+	+	+	+
Phylum Phoronida Order Diplostraca Suborder Cladocera					
Ewadne sp.	+	+	+	+	-
Phylum Phoronida Order Copepoda					
Calanoid sp.	+	+	+	+	+
Cyclopoid sp.	+	+	+	+	+
Order Decapoda					
Mysis	+	+	+	-	+
Zoea	+	+	+	+	+
Nauplii	+	+	+	+	-
Barnacle larvae	-	+	+	-	-
Phylum Mollusca					
Gastropod larvae	-	+	+	+	+
Lamellibranch larvae	-	-	-	+	+
Pteropods sp.	+	+	+	-	-
Phylum Echinodermata					
Echinoderm larvae	+	+	+	-	-
Fish egg	+	+	+	+	+
Fish larvae	+	+	+	+	+

+ =Present
- = Absent

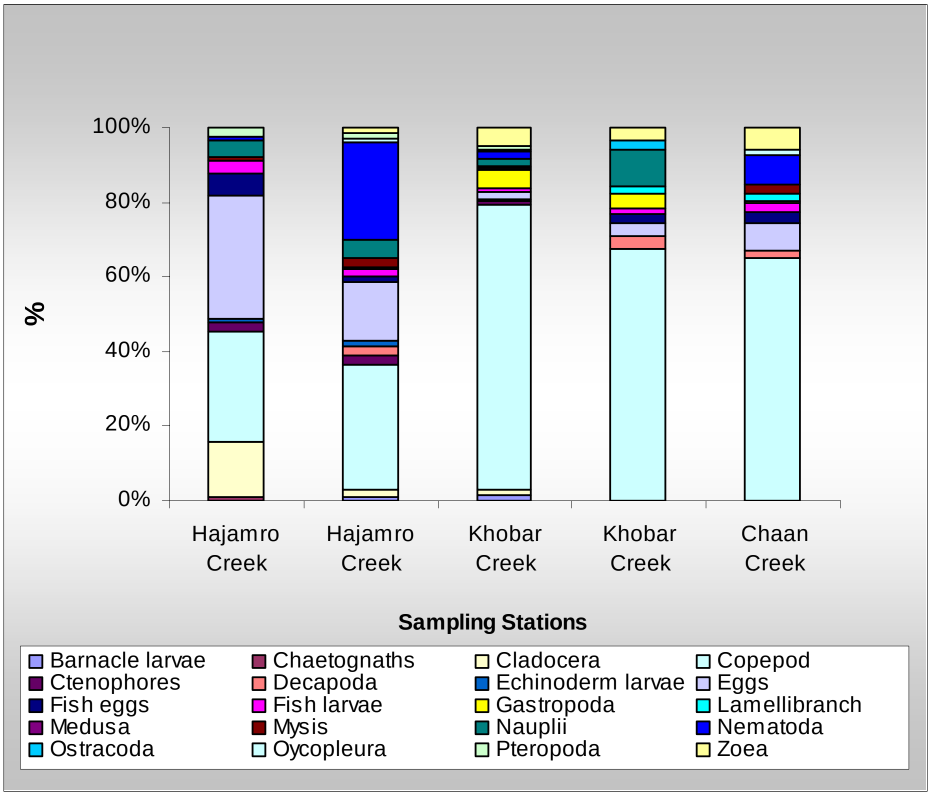


Figure 4: Distribution of Zooplankton at Keti Bunder

3.1.7.4 Macro invertebrates*:*

Highest number of organisms were observed at Khobar Creek, and included (copepods) *Herpecticoid sp*., *Foramaniferans sp*. and broken chelipeds of (fiddler crabs) *Uca sp*. (Table 25, Figure 5). The gastropods shells were found at all five stations and were abundant at Hajamro Creek.

Table 26: Checklist of Macro fauna and Meiofauna recorded at Keti Bunder

Sampling Stations	Hajamro Creek	Hajamro Creek	Khobar Creek	Khobar Creek	Chaan Creek
Bivalvia shells	0	0	18	0	4
Foramaniferans	0	0	12	0	0
Gastropod Shells	23	13	3	2	5
Herpacticoid	0	0	14	0	0
Nematods	2	0	1	2	0
Uca sp chelipede	1	0	1	0	0
Broken shells	Numerous	Few	Numerous	Few	Few

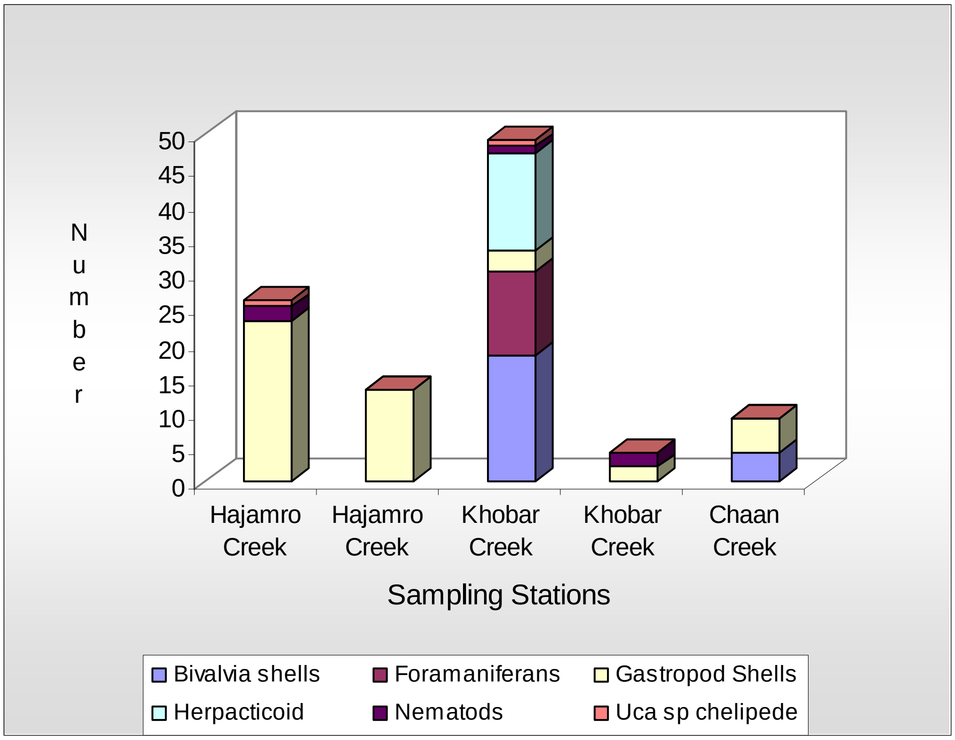
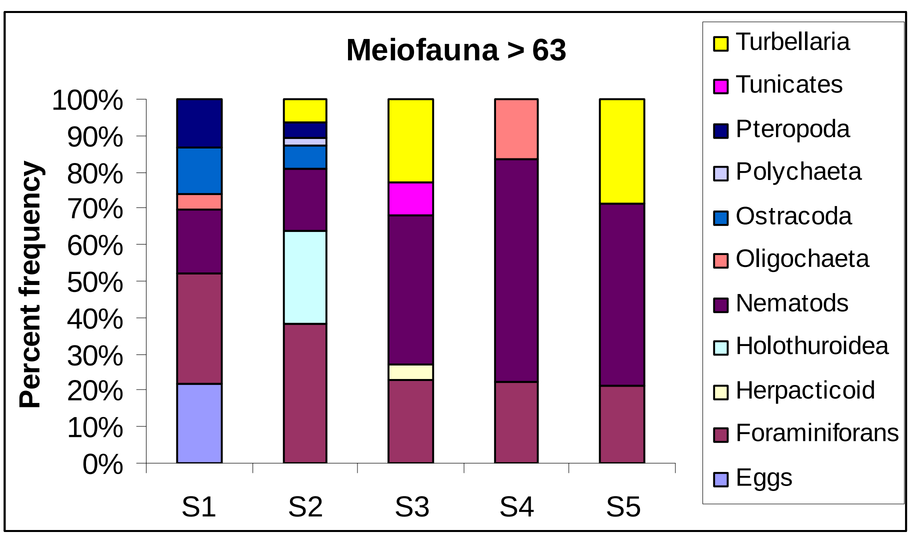


Figure 5: Distribution of Macrofauna at Keti Bunder

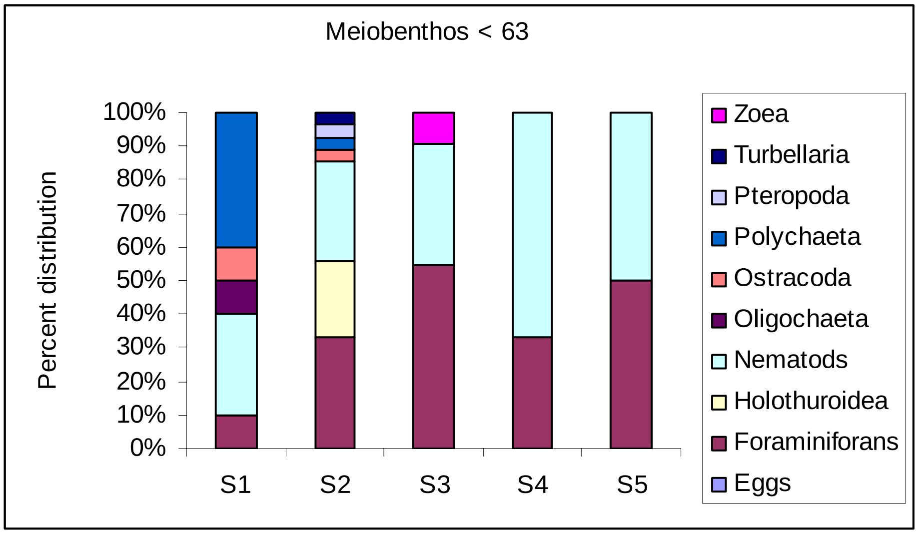
- ***Meiobenthos:***

The meiobenthic community varied at all the stations. Foramaniferans and nematodes were found at all five collection stations in both the samples > 63 mm and < 63 mm. The highest number of meiofauna was observed at S2. (Table 25, Figure 6 A & B).

Figure 6: Distribution of Meiobenthos > 63mm at Keti Bunder



A



B

3.1.7.5 Discussion

Phytoplankton and zooplankton are two of the common biological parameters collected because they form the base of the aquatic food web and influence other aspects of the aquatic ecosystem including color and clarity of the water and fish production. Phytoplanktons are microscopic plants that are an integral part of the aquatic ecosystem. They use nutrient in the water and sunlight to grow and are the base of aquatic food web. Zooplanktons are tiny animals that feed on phytoplankton and zooplankton. They are vital to the aquatic ecosystem and form the second level in the food web. The quantity and quality of phytoplankton is a good indicator of water quality. The high relative abundance of chlorophyta is indicative of productive water.

In the current study the aquatic habitat assessment was focused to the planktons and macro biota with physico chemical analysis of water. The diversity index and relative abundance were use to determine the water quality and overall situation for other aquatic fauna and flora of Kinjhar Lake, Chotiari reservoir and Keti Bunder.

- **Water quality:**

During the survey the pH was within the range of 7 which is also acceptable. The water quality was alkaline in nature *i.e*. more basic. As pH of water is important because many biological activities can occur only within a narrow range (Shepherd & Bromage, 1992). Oxygen plays very important role in determining the potential biological quality of water (Lloyd, 1992). In the present study the high value of Biological Oxygen Demand indicates the non suitable environment for the aquatic life (Table 22). Phenol and its derivatives which are present in many industrial effluents must be specifically treated because of their toxicity to the aquatic life and ecosystems.

High values of total suspended solids showing that there are excessive amount of organic matter which is not suitable for the aquatic life at Keti Bunder. The low values of chromium and cadmium indicting the water is not contaminated by heavy metals. Acceptable amount of phenol is present in the study areas.

Oil and grease present in the water samples are in high values which may be due to the mechanized boats used (Table 22).

- **Pesticides**

Pesticides that are soluble in both water and fats are usually taken up more quickly by man and animals as the traces of these pesticides along with their metabolites and break down products are ubiquitously present in abiotic and biotic environment (Tiel, 1972). Negative results for commercially used pesticides shows that the there are no traces of commercially exploited pesticides in the three sites (Annexure 6). But the further analysis showed the presence of the other pesticides namely Acetemride and Myalin in the samples of Keti Bunder and Chotiari Reservoir.

- **Planktons**

Stations S4 and S5 were less diverse than other stations for both greater than and less than 63 microns (Qureshi and Sultana 1999). The abundance of macrofauna was low at station S4 ad S5, presence of broken chelipeds of *Uca* indicate the species of this genus inhabit near by inter tidal areas.

Highest diversity was observed at S1 and S2 with high equitability index and species richness; however phytoplankton samples showed highest diversity at S3 and S5. (Table 25).Phytoplankton diversity was very low compared to study done for Kadero creek, Rehri; whereas zooplankton distribution was comparable (Table 26). It can be related to various environmental factors that include temperature, salinity, turbidity and nutrients as well as effect of grazing by zooplankton (Qureshi & Rabalais 2001, Dortch et al. 2001).

Table 27: Phytoplankton diversity indices at Keti Bunder:

Phytoplankton samples	Diversity H'	Equitability J'	Species Richness D''
Hajamro Creek	1.990	0.770	4.276
Hajamro Creek	1.987	0.768	3.566
Khobar Creek	2.839	0.819	2.862
Khobar Creek	1.059	0.456	2.176
Chaan Creek	2.014	0.779	-1.908

Table 28: Zooplankton diversity indices at Keti Bunder:

Zooplankton samples	Diversity H'	Equitability J'	Species Richness D''
S1	3.446	0.931	40.598
S2	3.664	0.916	33.327
S3	1.143	0.285	41.488
S4	1.750	0.526	24.290
S5	1.904	0.573	19.208

3.2-Kinjhar Lake

3.2.1 Natural Vegetation Assessment

FINDINGS OF THE NATURAL VEGETATION SURVEY

3.2.1.1 Phytosociological Studies of Kinjhar Lake

Transect No: 1

Site: Yousaf Haliya Coordinates: 24° 54' 40.8"N 68° 04' 08.5" E

Soil Type: Gravely Grazing Intensity: Moderate

Plant Community: *Cyno - Cyperus – Phylanthus* DMY: 123.5 Kg/ha

This site is located outside the embankment of the lake on eastern side. The entire landscape at this point has been encroached by Mesquite *(Prosopis juliflora)* while indigenous flora includes *Tamarix indica, Salvadora persica, Phyllanthus reticulatus*, *Launaea procumbense, Phyla nodiflora, Cynodon dactylon, Suaeda fruticosa, Portulaca sp., Cressa cretica, Trianthema pentendra, Phragmites karka and, Amaranthus graecizans*

Inside Bund vegetation consisted of *Fagonia indica, Cressa cretica, Salvadora persica, P. juliflora, Phragmites karka, Phylanthus sp., Cyperus articulatus, Suaeda fruticosa, Panicum sp., Alhagi mauroram, Amaranthus viridis, Pentatropis spiralis (climber),Portulaca sp., Salsola baryosma, Cynodon dactylon, Cyperus rotundus, Salonum surattense, Potamogeton perfoliatus., Ipomoea aquatica, Calotropis procera and, Oxystelma esculentum.*

Table 29: Phytosociological Parameters of T1 at Kinjhar Lake

Species	No	Composition	R.F. (%)	R.C %	R.D %	I.V.	SDR
Cyperus rotundus	108	30.59	14.63	13.54	30.59	58.77	19.59
Rhynchosia minima	3	0.85	7.32	1.22	0.85	9.39	3.13
Phyla nodiflora	4	1.13	9.76	2.59	1.13	13.47	4.49
Phyllanthus sp.	35	9.92	21.95	22.48	9.92	54.35	18.12
Salvadora persica	1	0.28	2.44	10.00	0.28	12.72	4.24
Launaea procumbense	1	0.28	2.44	0.51	0.28	3.23	1.08
Bleumea oblique	4	1.13	9.76	1.77	1.13	12.66	4.22
Dactyloctenum egyptium	1	0.28	2.44	0.61	0.28	3.33	1.11
Cynodon dactylon	165	46.74	17.07	9.05	6.74	92.86	30.95
Sporobolous kentrophyllus	21	5.95	4.88	1.26	5.95	12.09	4.03
Phragmitis karka	1	0.28	2.44	11.73	0.28	14.46	4.82
Oxystelma esculentum	9	2.55	4.88	5.31	2.55	12.73	4.24

Transect No: 2

Site:	Sonhari	Coordinates:	24° 59' 49.4"N 68° 06' 38.4" E
Soil Type:	Rocky, Gravely	Grazing Intensity:	Over Grazing
Plant Community:	*Zygophyllum*	DMY:	93.14 Kg/ha

This site is situated nearby a large village called Sonhari situated on eastern bank of the lake along road. This heavily grazed site is occupied with species like *Prosopis juliflora, Euphorbia caducifolia, Fagonia indica, Zygophyllum simplex, Trianthema sp., Euphorbia granulata, Calotropis procera, Cleome viscosa, Senna hochstettri, Datura alba, Indigofera hokteterii, Zizyphus nummularia, Achyranthes aspera, Amaranthus glaecizans, Physalis divancata, Tragus roxburghii Panigrahi, Commicarpus boissieri (climber), Eragrostris sp., Euphorbia serpense, Bilipharis sp., Aeluropus lagopoides, Dactyloctenum aristatum, and Cynodon dactylon.*

Table 30: Phytosociological Parameters of T2 at Kinjhar Lake

Species	No	Comp. (%)	R.F. (%)	Cover %	R.C. %	R.D %	I.V.	SDR
Prosopis glandulosa	1	0.52	1.43	4	4.45	1.03	6.91	2.30
Cleome viscose	3	1.56	4.29	1.2	1.34	3.09	8.71	2.90
Cressa cretica	2	1.04	2.86	0.48	0.53	2.06	5.45	1.82
Cyperus rotundus	2	1.04	2.86	0.58	0.65	2.06	5.56	1.85
Dactyoctenum aristatum	1	0.52	1.43	0.32	0.36	1.03	2.82	0.94
Eragrostris sp.	14	7.29	8.57	2.6	2.89	6.19	17.65	5.88
Euphorbia caducifolia	1	0.52	1.43	8.6	9.57	1.03	12.03	4.01
Euphorbia granulate	3	1.56	2.86	0.86	0.96	2.06	5.88	1.96
Fagonia indica	3	1.56	4.29	1.1	1.22	3.09	8.60	2.87
Indigofera hochteterii	1	0.52	1.43	1.2	1.34	1.03	3.79	1.26
Prosopis juliflora	2	1.04	2.86	4.68	5.21	2.06	10.13	3.38
Salvadora persica	3	1.56	1.43	0.46	0.51	2.06	4.00	1.33
Senna holosericea	17	8.85	10.00	9.08	10.10	10.31	30.41	10.14
Suaeda fruticosa	1	0.52	1.43	0.54	0.60	1.03	3.06	1.02
Tragus roxburghii Panigrahi	7	3.65	5.71	1.18	1.31	4.12	11.15	3.72
Trianthema portulacastum	1	0.52	1.43	0.58	0.65	1.03	3.10	1.03
Zygophylum simplex	129	67.19	44.29	52.18	58.06	55.67	158.01	52.67

Transect No: 3

Site: Khipri   Coordinates: 25° 00' 57.4"N 68° 07' 44.5" E

Soil Type: Gravely   Grazing Intensity: Over Grazing

Plant Community: *Cyperus – Cressa*   DMY: 116.1 Kg/ha

This site is gravely and situated inside the bank of Kinjhar Lake. There are poultry and livestock farms situated adjacent to this point. It is heavily grazed site. Plants have been grazed to the ground level. Plant species on this site include *P. juliflora, Cleome viscosa, Amaranthus sp., Corchorus trilocularis, Corchorus depressus, Indigofera hochstetteri, Blepharis, Atriplex stocksii, Euphorbia granulata, Euphorbia cadicifolia, Cynodon dactylon, Typha sp., Phragmites, Ipomoea aquatica, Salvadora persica, Heliotropeum sp., Xanthium indicum, Salvinia molesta and, Parkinsonia aculeata.*

Table 31: Phytosociological Parameters of T3 at Kinjhar Lake

Species	No	Comp. %	R.C. %	RF %	R.D %	I.V.	SDR
Alternanthera sessilis	3	0.4	0.67	1.27	0.55	2.48	0.83
Corchorus tridens	23	9.4	18.29	18.99	7.16	44.44	14.81
Corchorus depressus	1	0.4	0.71	1.27	0.28	2.25	0.75
Cleome viscose	3	1.2	2.42	3.80	0.28	6.49	2.16
Cressa cretica	41	16.7	16.28	20.25	42.42	78.96	26.32
Cyperus rotundus	138	56.3	28.85	21.52	40.22	90.59	30.20
Dactyloctenum aristatum	7	2.9	6.39	5.06	1.38	12.83	4.28
Eclipta prostate	3	1.2	0.25	3.80	0.55	4.60	1.53
Euphorbia granulate	1	0.4	1.63	1.27	0.28	3.17	1.06
Heliotropeum ovalifolium	12	4.9	8.43	10.13	2.20	20.76	6.92
Indigofera cordifolia	2	0.8	2.25	2.53	1.93	6.71	2.24
Indigofera hochsteteri	8	3.3	9.60	5.06	1.65	16.32	5.44
Launaea procumbense	1	0.4	0.38	1.27	0.28	1.92	0.64
Phyllanthus madraspatensis	3	1.2	2.88	2.53	0.55	5.96	1.99
Portulaca oleracea	1	0.4	0.96	1.27	0.28	2.50	0.83

Transect No: 4

Site: Gharo Shah (Island) Coordinates: 24^o 55' 24.8"N 68^o 02' 38.4" E
Soil Type: Gravely Grazing Intensity: No Grazing
Plant Community: *Cyperus – Cyno* DMY: 203.1 Kg/ha

This point is located on a big island inside the lake where a tomb of Gharo shah is located. Nearby to this point, just in the middle of water, tomb of legendary lady "Noori" is situated. The island has typical undisturbed vegetation comprised of old mature trees, shrubs and grasses which are hardly represented on the lake banks. The vegetation consists of species like *Acacia nilotica, Salvadora persica, P. juliflora, Phylanthus madraspatensis, Rhinchosia minima, Heliotropeum sp., Oxystelma esculatum, Pentatropis spiralis, Cyperus sp., Cynodon dactylon, Achyranthus sp., Senna holosericea, Phragmites karka, Ipomoea carnia, Corchorus triloularis, Potamogeton, Salvinia sp., Persicaria glabra, Coccinia, and Lannea sp.*

Table 32: Phytosociological Parameters of T4 at Kinjhar Lake

Species	No	Comp. %	R.C. %	R.F. %	R.D %	I.V.	SDR
Blumea oblique	4	1.1	1.77	10.81	3.24	15.82	5.27
Cynodon dactylon	165	46.7	29.03	13.51	27.53	70.07	23.36
Cyperus rotundus	116	32.9	14.48	18.92	51.42	84.82	28.27
Dactyloctenum aegyptium	1	0.3	0.61	2.70	0.81	4.12	1.37
Launaea procumbens	1	0.3	0.51	2.70	0.81	4.02	1.34
Oxystelma esculentum	1	0.3	4.35	2.70	0.81	7.86	2.62
Phragmitis karka	1	0.3	11.73	2.70	0.81	15.24	5.08
Phyla nodiflora	4	1.1	2.58	10.81	1.62	15.01	5.00
Phyllanthus madraspatensis	35	9.9	22.47	18.92	10.12	51.51	17.17
Rhynchosia minima	3	0.8	1.22	8.11	0.40	9.74	3.25
Salvadora persica	1	0.3	9.99	2.70	0.81	13.51	4.50
Sporobolous kentrophyllus	21	5.9	1.26	5.41	1.62	8.28	2.76

Transect No: 5

Site: Das Coordinates: 24° 54' 25.0"N 68° 01' 57.2" E

Soil Type: Gravely Grazing Intensity: Moderate Grazing

Plant Community: *Polycarpia – Grewia* DMY: 104.9 Kg/ha

This site is located near to T4 (Ghora Shah). Actually it is a ridge that looks like an island but in fact it is a spur connected with main land on south-western end. The vegetation is typical of low shrub dominated by grasses and forbs such as *Euphorbia cadicifolia, Prosopis. Juliflora, Launaea procumbens, Pentatropis spiralis, Polygala erioptera, Polycarpaea spicata, Hibiscus scindicus, Grewia, Convolvulus glomeratus, Aristida sp., Eragrostris, Tetrapogon tenellus, Corchorus sp., Lycium sp. Solanum cordatum, Solanum serratense, Oxystelma, Asparagus, Launaea cordifolia, Phragmites karka, Saccharum munja, Heliotropium sp., Blepharis.*

This rocky and gravely site was grazed heavily by the livestock of neighbouring villages. Fishing activity was also intense inside the typha growing adjacent to this ridge.

Table 33: Phytosociological Parameters of T5 at Kinjhar Lake

Species	No	Comp. %	R.C. %	R.F. %	R.D %	I.V.	SDR
Aristida adscensionis	4	3.4	1.38	4.44	6.29	12.11	4.04
Blepharis sindica	13	11.1	7.34	6.67	10.29	24.29	8.10
Blumea obliqua	1	0.9	2.25	2.22	0.57	5.04	1.68
Cleome brachycarpa	1	0.9	0.43	2.22	1.14	3.80	1.27
Convolvulus glomeratus	1	0.9	0.30	2.22	0.57	3.10	1.03
Cyperus rotundus	1	0.9	0.52	2.22	0.57	3.31	1.10
Dactyloctenum aegyptium	1	0.9	0.39	2.22	0.57	3.18	1.06
Eragrostris cilianensis	1	0.9	0.52	2.22	0.57	3.31	1.10
Euphorbia caducifolia	2	1.7	9.76	4.44	1.14	15.35	5.12
Fagonia indica	2	1.7	3.02	4.44	1.14	8.61	2.87
Glossonema varians	1	0.9	1.12	2.22	0.57	3.92	1.31
Grewia tenax	26	22.2	22.45	11.11	2.29	35.85	11.95
Hibiscus indica	2	1.7	4.58	4.44	1.14	10.16	3.39
Launaea procombense	1	0.9	1.30	2.22	0.57	4.09	1.36
Lycium edgeworthii	1	0.9	5.61	2.22	0.57	8.41	2.80
Tetrapogon tenellus	1	0.9	0.82	2.22	0.57	3.61	1.20
Octhochloa compressa	10	8.5	9.72	8.89	4.00	22.60	7.53
Polycarpaea spicata	25	21.4	5.57	6.67	46.29	58.52	19.51

Polygala erioptera	1	0.9	0.39	2.22	1.14	3.75	1.25
Prosopis juliflora	1	0.9	13.56	2.22	0.57	16.35	5.45
Rhynchosia minima	1	0.9	0.78	2.22	0.57	3.57	1.19
Sporobolus kentrophyllus	5	4.3	2.33	2.22	1.14	5.70	1.90
Tribulus terrestris	1	0.9	0.30	2.22	0.57	3.10	1.03
Zygophylum propinquum	14	12.0	5.27	15.56	17.14	37.97	12.66

Transect No: 6

Site: Amir Pir — Coordinates: 25^o 01' 17.3"N 68^o 05' 25.0" E
Soil Type: Gravely — Grazing Intensity: Moderate Grazing
Plant Community: *Eragrostris* — DMY: 103.7 Kg/ha

This point is located on a ridge on eastern side of a large village called Amir Pir. This village is vocational resort of Ismaili community of Karachi. The buildings and hygiene of the village clearly reflect the prosperity of the community and their respect for environment. Natural vegetation on site consisted of species like *Prosopis cineraria, Euphorbia caudicifolia, Salvadora persica, Zygophylum simplex, Aristida adscensionis, Eragrostris ciliaris, Tetrapogon tenellus, Suaeda fruticosa, Dactyloteneum aegyptium, Zygophylum propinquum, Digera muricata, Indigofera cordifolia, Blepharis scindica, Cleome viscosa, Cleome brachycarpa, Polygala irregularis , Aerva javanica, Octhocloa compressa, Euphorbia serpense, Pentatopsis nivalis, Atriplex stocksii and, Tribulus terrestris.*

Table 34: Phytosociological Parameters of T6 at Kinjhar Lake

Species	No	Comp. %	Rel. C %	R.F. %	R.D %	I.V.	SDR
Aristida adscensionis	2	1.57	0.98	1.24	2.33	4.55	1.52
Blepharis scindica	20	15.75	14.14	12.42	1.17	27.73	9.24
Cleome scaposa	1	0.79	0.30	1.24	0.78	2.32	0.77
Cometes surattensis	1	0.79	0.21	3.11	22.57	25.89	8.63
Cyprus rotundus	2	1.57	1.06	2.48	0.78	4.32	1.44
Digera muricata	1	0.79	0.55	1.24	0.39	2.18	0.73
Aristida adscensionis	2	1.57	1.36	2.48	4.67	8.51	2.84
Erogrostris ciliaris	14	11.02	4.93	9.94	26.07	40.93	13.64
Indigofera cordifolia	4	3.15	2.29	4.97	1.56	8.82	2.94
Tetrapogon tenellus	1	0.79	1.61	1.24	0.39	3.24	1.08
Octhocloa compresa	2	1.57	6.28	2.48	0.78	9.55	3.18
Prosopis juliflora	2	1.57	8.41	2.48	0.78	11.67	3.89
Zygophylum simplex	75	59.06	57.88	54.66	37.74	150.28	50.09

Transect No: 7

Site: Mokhli   Coordinates: 24° 58' 0.25"N 68° 01' 39.2" E
Soil Type: Gravely   Grazing Intensity: Heavy Grazing
Plant Community: *Cyperus*   DMY: 50.9 Kg/ha

It is a pasture situated at the bank of lake. This site is inundated from time to time especially during winter. There were a lot of Red Sindhi cattle grazing on this site which were brought from a place called Sajawal just for grazing purpose. Natural vegetation over here consisted of *Phoenix dactylifera, P. juliflora, Ipomoea, Typha sp..* There was a pure mat of *Cyperus rotundus. Cyperus articulate* was also present. Other plant species included *Phyla nodiflora, Cynodon dactylon, Ipomoea carnia, Salvinia molesta., Eclipta prostata, Persicaria glabra, Potamogeton perfoliatus, Schoenoplectus sp .*

Table 35: Phytosociological Parameters of T7 at Kinjhar Lake

Species	No	Comp. %	R.C. %	R.F. %	R.D %	I.V.	SDR
Cynodon dactylon	23	8.33	26.69	13.33	22.28	62.30	20.77
Cyperus articulate	218	78.99	50.24	60.00	70.46	180.70	60.23
Eclipta prostata	2	0.72	1.07	2.67	0.83	4.56	1.52
Phyla nudiflora	28	10.14	18.37	18.67	5.61	42.65	14.22
Prosopis juliflora	2	0.72	2.73	2.67	0.33	5.73	1.91
Schoenoplectus sp	3	1.09	0.89	2.67	0.50	4.05	1.35

Transect No: 8

Site: Ibrahim Shah   Coordinates: 24° 55' 42.3"N 67° 59' 06.0" E

Soil Type: Gravely   Grazing Intensity: Over Grazing
Plant Community: *Cynodon*   DMY: 81.7 Kg/ha

It is an extremely degraded area dotted with frequent animal droppings and infested heavily by *Prosopis juliflora.* Other plant species present were *Acacia nilotica, Salvadora persica, Alhagi mauroram.* Acacia *nilotica* trees were severely browsed by goats. Other species found were *Phyla nodiflora, Cyperus sp., Makita medraspatana, Pentatropis spiralis, spiratis, Aeluropus lagopoides, Lannea* *procumbense, Cynodon dactylon, Blumea obliqua, Tamarix indica, Corchorus trilocularis and Tribulus terristris.*

Table 36: Phytosociological Parameters of T8 at Kinjhar Lake

Species	No	Comp. %	R.C %	RF (%)	R.D %	I.V.	SDR
Aeluropis lagopoidis	41	23.98	15.93	25.93	0.51	42.36	14.12
Alhagi maurorum	3	1.75	3.79	3.70	0.68	8.17	2.72
Blumea oblique	1	0.58	0.89	1.23	0.17	2.29	0.76
Corchorus trilocularis	1	0.58	0.12	1.23	0.17	1.52	0.51
Cynodon dactylon	80	46.78	46.15	33.33	50.00	129.49	43.16
Cyperus articulata	5	2.92	1.12	2.47	41.39	44.98	14.99
Eragrostris	1	0.58	0.43	1.23	0.17	1.83	0.61
Launaea procumbens	22	12.87	7.61	16.05	4.73	28.39	9.46
Phyla nodiflora	11	6.43	13.95	11.11	1.18	26.25	8.75
Prosopis juliflora	6	3.51	10.01	3.70	1.01	14.73	4.91

Transect No: 9

Site: Chilia Bend Coordinates: N 24 58 0.25, E 68 01' 39.2`

Soil Type: Gravely Grazing Intensity: Moderate Grazing

Plant Community: *Aristida* DMY: 194.5 Kg/ha

This site is situated on western side of the lake where lake transforms into a narrow channel. The transect was located on a southern faced slope representing a potential grassland dotted with *Euphorbia cadicifolia.* Other species included *Suaeda fruticosa, Aerva javanica, Digera muricata, Senra incana, Grewia tenax, Euphorbia cadicifolia, Cleome scaposa, Corchorus trilocularis, Heliotropeum ophioglossum, Inula granitoides, Blepharis scindica, Maerua arenaria, Zygophylum propinquum, Argyrolobium roseum, Tavernaria cuneifolia, Aerva javanica, Commicarpus boissieri. Aeluropus lagopoides* is present near edge of lake.

Table 37: Phytosociological Parameters of T9 at Kinjhar Lake

Species	No	Comp. %	R.C. %	R.F (%)	R.D %	I.V.	SDR
Ochthochloa compressa	23	8.88	22.57	11.11	3.18	36.86	12.29
Amaranthus viridis	1	0.39	0.15	0.85	0.24	1.25	0.42
Aristida sp	64	24.71	11.20	11.97	59.41	82.58	27.53
Blepharis scindica	7	2.70	2.91	5.98	0.24	9.14	3.05
Boerhavia procumbens	1	0.39	0.43	0.85	0.24	1.53	0.51
Cleome scaposa	3	1.16	1.07	1.71	1.96	4.74	1.58

Cressa cretica	18	6.95	4.19	8.55	2.20	14.94	4.98
Cyperus sp	1	0.39	0.31	0.85	0.24	1.41	0.47
Dactylocteneum scindicum	1	0.39	1.02	0.85	0.24	2.12	0.71
Dirgera muricata	4	1.54	0.66	0.85	0.49	2.01	0.67
Eragrostris sp	9	3.47	2.56	3.42	1.22	7.20	2.40
Euphorbia granulata	9	3.47	7.31	5.13	0.49	12.93	4.31
Fagonia indica	3	1.16	1.05	2.56	0.24	3.86	1.29
Indigofera cordifolia	1	0.39	0.05	0.85	0.98	1.88	0.63
Indigofera hochstetteri	1	0.39	0.31	0.85	0.24	1.41	0.47
Inula grantioides	2	0.77	0.26	1.71	0.24	2.21	0.74
Polygala erioptera	2	0.77	0.56	1.71	0.24	2.52	0.84
Prosopis juliflora	2	0.77	5.96	1.71	0.49	8.15	2.72
Senna holosericia	1	0.39	0.61	0.85	0.24	1.71	0.57
Senra incana	1	0.39	1.99	0.85	0.24	3.09	1.03
Sporobolus sp	5	1.93	0.36	1.71	0.49	2.56	0.85
Tephrosia uniflora	3	1.16	0.28	2.56	0.49	3.33	1.11
Tribulus terrestris	1	0.39	0.31	0.85	0.24	1.41	0.47
Zygophyllum simplex	96	37.07	33.87	31.62	25.67	91.17	30.39

Table 38: Summary of Plant Communities**,** Associated species and forage production in Kinjhar Lake

Site #	Site	Coordinates	Plant Community	Vegetation type and dominant species	Soil Type	DMY (Kg/ha)	Grazing condition
T-1	Yousaf Haliya	24° 54' 40.8"N 68° 04' 08.5" E	*Cyno – Cyperus – Phylanthus*	*Fagonia indica, Cressa cretica, salvadora persica, P. juliflora, Phragmites karka, Phylanthus sp., Cyprus articulatus, Suaeda fruticosa, Panicum sp., Salsola baryosma, Cynodon dactylon,Cyperus rotundus, Potamogetus sp., Ipomaea aquatica, Calotropis procera, Oxystelma sp.*	Stony, Gravely	123.5	Moderate
T-2	Sonhari	24° 59' 49.4"N 68° 06' 38.4" E	*Zygophyllum simplex*	*Prosopis juliflora, Euphorbia caducifolia, Fagonia indica, Zygophyllum simplex, Trianthema sp., Euphorbia granulata, Calotropis procera, Cleome viscosa, Senna holosericea, Datura alba, Tragus sp., Commicarpus (climber), Eragrostris sp., and Cynodon dactylon,*	Rocky, Gravelly		Over grazed
T-3	Khipri	25° 00' 57.4"N 68° 07' 44.5" E	*Cyperus – Cressa*	*Ipomoea (shrubs), P. juliflora, Cleome viscosa, Amaranthus sp., Corchorus trilocularis, Corchorus depressus, Indigofera hochstettri, Blepharis, Atriplex sp., Euphorbia granulata, Euphorbia cadicifolia, Cynodon dactylon, Salvinia, Typha sp., Phragmites,*	Gravelly	116.1	Over Grazed

T-4	Gharo Shah (Island)		*Cyperus – Cyno*	*Acacia nilotica, Salvadora persica, P. juliflora, Phyllanthus, Rhynchosia minima, Heliotropium sp., Oxystelma, Pentatropis spiralis, Cyprus sp., Cynodon dactylon, Achyranthis sp., Senra incana, Phragmites karka, Ipomoea carnea, Corchorus trilocularis, Potamogeton, Salvinia sp., Persicaria glabra, Coccinia,and Launaea sp.*	**Gravely**	203.1	No Grazing
T5	Das	24^o 54' 25.0"N 68^o 01' 57.2" E	*Polycarpia – Grewia*	*Euphorbia cadicifolia, Prosopis. juliflora. Launaea procumbense, Pentatropis spiralis, Polygala, Polycarpaea, Hibiscus sindicus, Grewia, Convolvulus glomeratus, Aristida sp., Eragrostris, Tetrapogon tenellus, Corchorus sp., Lycium sp. Solanum cordatum, Solanum surattense, Oxystelma, Asparagus,Phragmites karka, Saccharum munja, Heliotropium sp., Blepharis.*	Gravely	104.9	Moderate
T6	Amir Pir	25^o 01' 17.3"N 68^o 05' 25.0" E	*Eragrostris*	*Prosopis cineraria, Euphorbia cadicifolia, Salvadora persica, Zygophylum simplex, Aristida sp., Eragrostris sp., Tetrapogon tenellus, Suaeda fruticosa, Dactyloteneum, Zygophylum propinquinum, Digera aaspera, Indigofera cordifolia, Blepharus,*	Gravely	103.7	Moderate
T7	Mokhli	24^o 58' 0.25"N 68^o 01' 39.2" E	*Cyprus*	*Phoenix dactylifera, P. juliflora, Ipomoea, Typha sp., Pure mat of Cyperus sp. Cyprus articulata also present. Phyla nodiflora, Cynodon dactylon, Prosopis juliflora, Ipomoea carnia, Salvinia sp., Eclipta prostata, Persicaria glabra, Pota mogeton.*	silt-loam	50.9	Over Grazing
T8	Ibrahim	24^o 55' 42.3"N 67^o	*Cynodon*	*Prosopis juliflora.* Other plant species present were *Acacia*	Gravely	81.7	Over

	Shah	59’ 06.0” E		*nilotica, Salvadora persica, Alhagi maurorum.* Acacia *nilotica* trees were severely grazed by goats. Other species found included *Phyla nodiflora, Prosopis juliflora, Acacia nilotica, Cyprus, Mukia maderaspatan, Pentatropsis spiratis, Aleuropus lagopoides, Lannea procumbense, Alhaji maurorum, Cynodon dactylon, Blumea, Tamarix and Corchorus and Trilocularis.*			Grazed
T9	Chilia Bend	N 24 58 0.25 E 68 01' 39.2`	*Aristida*	*Senra incana, Grewia tenax, Euphorbia cadicifolia, Cleome scaposa, Cochorus trilocalaris, Heliotropium sp., Inula granitoides, Blepharus sindica, Merva arneria, Zygophylum propinquium, Argariolobium sp., Taverneria sp., Aerva jwanica, Commicorpus boisi.. Aleuropis lagopoides*	Gravely	194.5	Moderate Grazing

3.2.1.2 Summary of Kinjhar Flora

Vegetation assessment of Kinjhar was carried out from 19th to 20th September, 2006. Some 139 plant species belonging to 104 genera and 40 families are identified. Of them, 21 grasses (Poaceae family) have been identified. The major plant families which contributed in the formation of vegetation in the area in question are Poaceae (15.12%) followed by Papilionaceae (7.19%), Compositae (5.04%), Amaranthaceae (4.32%), Boraginaceae (4.32%), Chenopodiaceae (4.32%), Capparidaceae (3.6%), Euphorbiaceae (3.6%), Tiliaceae (3.6%) and Solanaceae (3.6%). The alphabetical checklist of species along their family, vernacular names and life form/habit is provided (Table 38). Dry matter forage and animal units are also presented in Table 39.

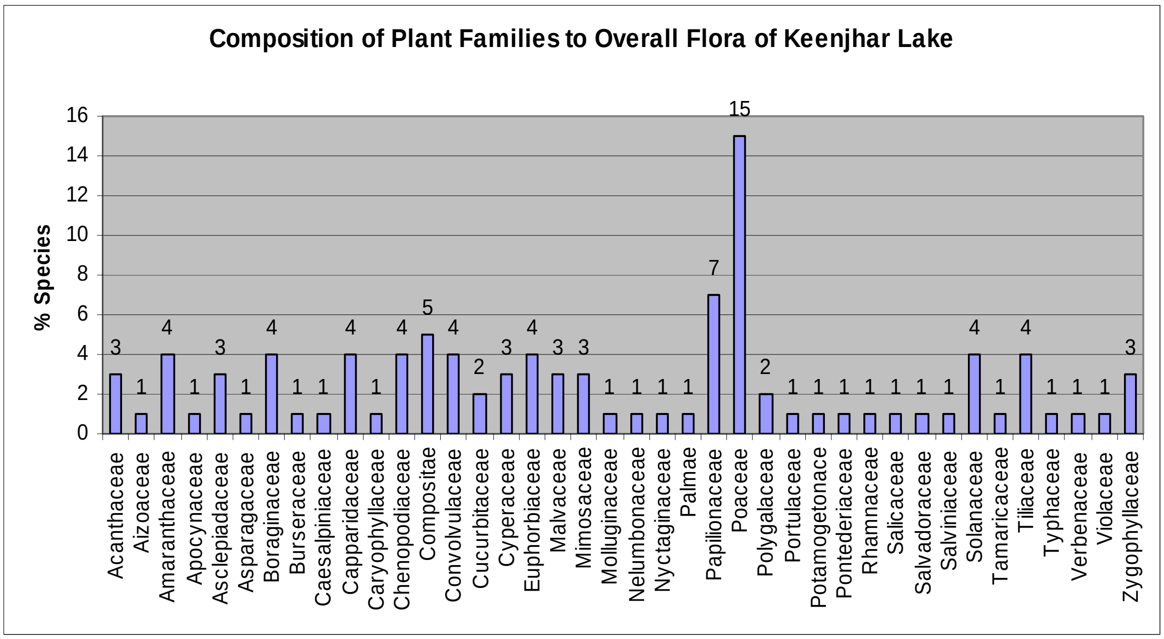


Figure 7: Composition of Plant families to Overall Flora of Kinjhar Lake

Table 39: Flora of Kinjhar Lake

S.#	Family	Plant species	Life form	Habit
01	Acanthaceae	*Barleria acanthoides* Vahl	Phanerophyte	Shrub
02	Acanthaceae	*Barleria prionitis* L.	Phanerophyte	Shrub
03	Acanthaceae	*Blepharis sindica* Stocks ex T. And.	Therophyte	Herb
04	Acanthaceae	*Ruellia patula* var. *alba* Saxton	Phanerophyte	Shrub
06	Aizoaceae	*Trianthema portulacastum* L.	Therophyte	Herb
07	Aizoaceae	*Zaleya pentandra* (L.) Jeffery.	Chamaephyte	Herb
08	Amaranthaceae	*Achyranthes aspera* L.	Chamaephyte	Robust herb
09	Amaranthaceae	*Aerva javanica* (Burm.f.)Juss.	Phanerophyte	Robust herb
10	Amaranthaceae	*Alternanthera sessilis* (L.) DC.	Chamaephyte	Herb
11	Amaranthaceae	*Amaranthus graecizans* L.	Therophyte	Herb
12	Amaranthaceae	*Amaranthus viridis* L.	Therophyte	Herb
13	Amaranthaceae	*Digera muricata* (L.) Mart.	Therophyte	Herb
14	Apocynaceae	*Rhazya stricta* Decene	Phanerophyte	Shrub
15	Asclepiadaceae	*Calotropis procera* (Willd.) R. Br.	Phanerophyte	Shrub
16	Asclepiadaceae	*Glossonema varians* (Stocks) Benth.	Therophyte	Herb
17	Asclepiadaceae	*Oxystelma esculentum* (L.f.) R.Br.	Cryptophyte	Herb
18	Asclepiadaceae	*Pentatropis nivalis* (J.F.Gmel.) Field & J.R.I.Wood	Phanerophyte	Climber
19	Asparagaceae	*Asparagus dumosus* Baker	Cryptophyte	Shrub
20	Boraginaceae	*Cordia gharaf* (Forsk.) Ehren. ex Asch.	Phanerophyte	Tree
21	Boraginaceae	*Heliotropium calcareum* Stocks	Chamaephyte	Herb
22	Boraginaceae	*Heliotropium curassavicum* L.	Chamaephyte	Herb
23	Boraginaceae	*Heliotropium ophioglossum* Boiss.	Chamaephyte	Herb/subshrub
24	Boraginaceae	*Heliotropium ovalifolium* Forsk.	Chamaephyte	Herb
25	Boraginaceae	*Trichodesma indicum* (L.) R. Br.	Phanerophyte	Shrub
26	Burseraceae	*Commiphora stocksiana* (Engler) Engler	Phanerophyte	Large shrub
27	Caesalpiniaceae	*Parkinsonia aculeata* L.	Phanerophyte	Tree
28	Caesalpiniaceae	*Senna holosericea* (Fresen.) Greuter	Phanerophyte	shrub
29	Capparidaceae	*Cleome brachycarpa* Vahl ex DC.	Chamaephyte	Herb
30	Capparidaceae	*Cleome scaposa* DC.	Therophyte	Herb
31	Capparidaceae	*Cleome viscosa* L.	Therophyte	Herb
32	Capparidaceae	*Gynandropsis gynandra* (L.) Briq.	Therophyte	Herb
33	Capparidaceae	*Maerua arenaria* (DC) H & T.	Phanerophyte	Shrub
34	Caryophyllaceae	*Cometes surattensis* Burm.	Therophyte	Herb
35	Caryophyllaceae	*Polycarpaea spicata* Wight & Arm.	Therophyte	Herb
36	Chenopodiaceae	*Atriplex stocksi* Boiss.	Chamaephyte	Subshrub
37	Chenopodiaceae	*Chenopodium album* L.	Therophyte	Herb
38	Chenopodiaceae	*Chenopodium murale* L.	Therophyte	Herb
39	Chenopodiaceae	*Haloxylon stocksii* (Boiss.) Benth. & Hooker	Phanerophyte	Shrub
40	Chenopodiaceae	*Salsola imbricata* Forsk.	Phanerophyte	shrub
41	Chenopodiaceae	*Suaeda fruticosa* Forsk. Ex J.F. Gmelin	Phanerophyte	Shrub
42	Compositae	*Blumea obliqua* (L.) Druce	Chamaephyte	Herb
43	Compositae	*Eclipta prostrata* (L.) L.	Chamaephyte	Herb
44	Compositae	*Iphiona grantioides* Boiss	Chamaephyte	Herb
45	Compositae	*Launaea procumbens* (Roxb.) Amin.	Chamaephyte	Herb
46	Compositae	*Launaea remotiflora* (DC.) Stebbins	Therophyte	Herb
47	Compositae	*Vernonia cinerascens* Schultz. Bip.	Phanerophyte	Shrub
48	Compositae	*Xanthium strumarium* L.	Phanerophyte	Shrub
49	Convolvulaceae	*Convolvulus glomeratus* Choisy	Phanerophyte	Herb
50	Convolvulaceae	*Convolvulus rhyniospermus* Hochst.	Therophyte	Herb
51	Convolvulaceae	*Cressa cretica* L.	Chamaephyte	Herb
52	Convolvulaceae	*Ipomoea aquatica* Forsk.	Hydrophyte	Herb
53	Convolvulaceae	*Ipomoea carnea* Jacq.	Phanerophyte	Shrub
54	Convolvulaceae	*Ipomoea sindica* Stapf	Therophyte	Climber
55	Cucurbitaceae	*Coccinia grandis* (L.) Voigt	Phanerophyte	Creeper
56	Cucurbitaceae	*Luffa echinata* Roxb.	Phanerophyte	Climber
57	Cucurbitaceae	*Mukia maderaspatana* (L.) M.J.Roem.	Phanerophyte	Climber
58	Cyperaceae	*Bulboschoemis affinis* (Roth) Drobov	Cryptophyte	Sedge
59	Cyperaceae	*Cyperus articulatus*	Cryptophyte	Sedge

60	Cyperaceae	*Cyperus rotundus* L.	Cryptophyte	Sedge
61	Cyperaceae	*Cyperus stoloniferus* Retz.	Cryptophyte	Sedge
62	Euphorbiaceae	*Euphorbia caducifolia* Haines	Phanerophyte	Shrub
63	Euphorbiaceae	*Euphorbia granulata* Forsk.	Therophyte	Herb
64	Euphorbiaceae	*Euphorbia serpens* Kunth	Therophyte	Herb
65	Euphorbiaceae	*Phyllanthus madraspatensis* L.	Therophyte	Herb
66	Euphorbiaceae	*Phyllanthus reticulatus* Poir.	Phanerophyte	Shrub
67	Malvaceae	*Abutilon fruticosum* Guill.	Phanerophyte	Shrub
68	Malvaceae	*Hibiscus micranthus* L.f.	Chamaephyte	Shrub
69	Malvaceae	*Hibiscus scindicus* Stocks	Phanerophyte	Shrub
70	Malvaceae	*Senra incana* Cav.	Phanerophyte	Shrub
71	Mimosaceae	*Acacia nilotica* Delile	Phanerophyte	Tree
72	Mimosaceae	*Acacia senegal* (L.)Willd.	Phanerophyte	Tree
73	Mimosaceae	*Prosopis glandulosa* Torr.	Phanerophyte	Shrub
74	Mimosaceae	*Prosopis juliflora* DC.	Phanerophyte	Tree
75	Molluginaceae	*Corbichonia decumbens* (Forsk.) Exell	Therophyte	Herb
76	Nelumbonaceae	*Nelumbo nucifera* Gaertn.	Hydorphyte	Herb
77	Nyctaginaceae	*Boerhavia procumbens* Banks ex Roxb.	Cryptophyte	Herb
78	Nyctaginaceae	*Commicarpus boissieri* (Heimerl) Cufod.	Phanerophyte	Herb
79	Palmae	*Phoenix dactylifera* L.	Phanerophyte	Tree
80	Papilionaceae	*Alhagi maurorum* Medic.	Chamaephyte	Shrub
81	Papilionaceae	*Argyrolobium roseum* (Camb.) Jaub. & Spach.	Therophyte	Herb
82	Papilionaceae	*Indigofera cordifolia* Heyne ex Roth	Therophyte	Herb
83	Papilionaceae	*Indigofera hochstetteri* Baker	Therophyte	Herb
84	Papilionaceae	*Indigofera linifolia* (L.f.) Retz.	Therophyte	Herb
85	Papilionaceae	*Indigofera oblongifolia* Forsk.	Phanerophyte	Shrub
86	Papilionaceae	*Rhynchosia minima* (L.) DC.	Phanerophyte	Climber
87	Papilionaceae	*Taverniera cuneifolia* (Roth.) Arnott	Phanerophytes	Subshrub
88	Papilionaceae	*Tephrosia strigosa* (Dalz.) Sant. & Mah.	Therophyte	Herb
89	Papilionaceae	*Vigna trilobata* (L.) Verdc.	Therophyte	Herb
90	Poaceae	*Aeluropus lagopoides* (L.) Trin. Ex Thw.	Hemicryptophyte	Grass
91	Poaceae	*Aristida adscensionis* L.	Therophyte	Grass
92	Poaceae	*Brachiaria ramosa* (L.) Stapf	Therophyte	Grass
93	Poaceae	*Cenchrus ciliaris* L.	Hemicryptophyte	Grass
94	Poaceae	*Cenchrus prieurii* (Kunth) Maire	Hemicryptophyte	Grass
95	Poaceae	*Chrysopogon aucheri* (Boiss.) Stapf.	Hemicryptophyte	Grass
96	Poaceae	*Cynodon dactylon* (L.) Pers.	Hemicryptophyte	Grass
97	Poaceae	*Dactyloctenium aegyptium* (L.) P. Beauv.	Therophyte	Grass
98	Poaceae	*Dactyloctenium aristatum* Link	Therophyte	Grass
99	Poaceae	*Dactyloctenium scindicum* Boiss.	Therophyte	Grass
100	Poaceae	*Desmostachya bipinnata* (L.) Stapf	Cryptophyte	Grass
101	Poaceae	*Echinochloa colonum* (L.) Link	Therophyte	Grass
102	Poaceae	*Elionurus royleanus* Nees ex A.Rich.	Therophyte	Grass
103	Poaceae	*Eragrostis ciliaris* (L.) R. Br.	Therophyte	Grass
104	Poaceae	*Eragrostis cilianensis* (All.) Vig.	Therophyte	Grass
105	Poaceae	*Ochthochloa compressa* (Forsk.) Hilu	Hemicryptophyte	Grass
106	Poaceae	*Phragmites karka* (Retz.) Trin.	Cryptophyte	Tall grass
107	Poaceae	*Saccharum spontaneum* L.	Hemicryptophyte	Tall grass
108	Poaceae	*Sporobolus kentrophyllus* (K. Schum.) W.D. Clayton	Hemicryptophyte	Grass
109	Poaceae	*Tetrapogon tenellus* (Koen. Ex Roxb.) Chiov.	Therophyte	Grass
110	Poaceae	*Tragus roxburghii* Panigrahi	Therophyte	Grass
111	Polygalaceae	*Polygala erioptera* DC.	Therophyte	Herb
112	Polygalaceae	*Polygala irregularis* Boiss	Chamaephyte	Herb
113	Polygonaceae	*Persicaria glabra* (Willd.) Gomes de la Maza	Phanerophyte	Herb
114	Portulacaceae	*Portulaca oleracea* L.	Therophyte	Herb
115	Potamogetonaceae	*Potamogeton perfoliatus* L.	Hydrophyte	Herb
116	Pontederiaceae	*Eichhornia crassipes* (Mart.) Schlecht.	Hydrophyte	Herb
117	Rhamnaceae	*Ziziphus mummularia* (Burm.f.) Wight & Arn.	Phanerophyte	Shrub
118	Salicaceae	*Populus euphratica* Olivier	Phanerophyte	Tree
119	Salvadoraceae	*Salvadora oleoides* Decne.	Phanerophyte	Tree
120	Salvadoraceae	*Salvadora persica* L.	Phanerophyte	Tree

121	Salviniaceae	*Salvinia molesta* Mitchelle	Hydrophyte Fern	Herb
122	Solanaceae	*Datura alba* Nees	Phanerophyte	Shrub
123	Solanaceae	*Lycium edgeworthii* Dunal	Phanerophyte	Shrub
124	Solanaceae	*Physalis divaricata* D. Don	Therophyte	Herb
125	Solanaceae	*Solanum cordatum* Forssk.	Phanerophyte	Straggling shrub
126	Solanaceae	*Solanum surattense* Burm.f.	Therophyte	Herb
127	Tamaricaceae	*Tamarix indica* L.	Phanerophyte	Tree
128	Tiliaceae	*Corchorus depressus* (L.) Stocks	Chamaephyte	Subshrub
129	Tiliaceae	*Corchorus tridens* L.	Therophyte	Herb
130	Tiliaceae	*Corchorus trilocularis* L.	Therophyte	Herb
131	Tiliaceae	*Grewia tenax* (Forssk.) A. & S.	Phanerophyte	Shrub
132	Tiliaceae	*Grewia villosa* Willd.	Phanerophyte	Shrub
133	Typhaceae	*Typha sp*	Cryptophyte	Reed
134	Verbenaceae	*Phyla nodiflora* (L.) Greene	Chamaephyte	Herb
135	Violaceae	*Viola stocksii* Boiss.	Therophyte	Herb
136	Zygophyllaceae	*Fagonia indica* Burm.f.	Chamaephyte	Herb
137	Zygophyllaceae	*Tribulus terrestris* L.	Therophyte	Herb
138	Zygophyllaceae	*Zygophyllum propinquum* Decne.	Chamaephyte	Herb/subshrub
139	Zygophyllaceae	*Zygophyllum simplex* L.	Therophyte	Herb

Table 40: Forage Dry Matter Yield and Carrying Capacity of Kinjhar Lake

Transect No.	Total Dry Matter Forage (Kg/ha)	Available Forage (Kg/ha)	A.U
1	123.5	74.1	10.59
2	93.1	55.9	7.98
3	116.1	69.66	9.95
4	203.1	121.86	17.41
5	104.9	62.94	8.99
6	103.7	62.22	8.89
7	50.9	30.54	4.36
8	81.7	49.02	7
9	194.5	116.7	16.67

3.2.1.3 *Two Ways Indicator Species Analysis (TWINSPAN)*

Cover data from transects of each of the three sites (Keti Bundar, Kinjhar, Chotiari) were compiled using spreadsheet programme Microsoft® Excel®. These values ware then analyzed using software "*Two Ways Indicator Species Analysis (TWINSPAN)*" as mentioned earlier in Materials & Methods section. The results of the analysis for Kinjhar Lake are described as under.

Flora at different land-forms of Kinjhar was represented by overall three plant communities, as described below.

- ***Cyperus – Cynodon - Phylanthus***
  This plant community was found on transects 3, 4, 7 and 8. All these four transects were laid out near the edge of water body. Thus Plant species of *Cyperus articulatus and Cynodon dactylon (both* Chamaephyte *and belonging to* Poaceae) are characteristic species of such land form followed by *Phyllanthus reticulatus which is* Phanerophyte and belong to Euphorbiaceae.

- ***Zygophylum – Grewia***
  This plant community comprised of *Eragrostis ciliaris and Grewia tenax was found on Transects 2, 5, 6 and 9. All these sites are represented by gravely soil dotted with grasses and shrubs. Both the plant species forming this community (Eragrostis ciliaris and Grewia tenax) belong to* Poaceae and Tiliaceae families and have life forms of Therophyte and Phanerophyte, respectively.

- ***Eragrostis – Cyperus - Zygophyllum***
  This plant community is represented by three species *Eragrostis ciliaris, Cyperus articulatus and, Zygophyllum simplex. This community was also found on Transects 2, 5, 6 and 9 in association with plant community 2.* This plant community was again dominated by Poaceae family with Therophytes and Zygophyllaceae again with Therophyte.

Table 41: TWINSPAN Analysis - Kinjhar

		Transect No.								
	Plant Species	3	4	7	8	2	5	6	9	1
2	*Suaeda fruticosa*	-	-	-	-	1	-	-	-	5
1	*Salvadora persica*	-	-	-	-	1	-	-	-	5
55	*Aeluropus lagopoides*	-	-	-	1	-	-	-	-	-
54	*Solanum cordatum*	-	-	1	3	-	-	-	-	-
34	*Salvadora oleoides*	-	3	-	-	-	-	-	-	-
32	*Phyla nodiflora*	-	1	3	3	-	-	-	-	-
31	*Phragmites karka*	-	3	-	-	-	-	-	-	-
30	*Oxystelma esculentum*	-	2	-	-	-	-	-	-	-
29	*Cynodon dactylon*	-	4	3	5	-	-	-	-	-
28	*Blumea oblique*	-	1	-	-	-	-	-	-	-
27	*Portulaca oleracea*	1	-	-	-	-	-	-	-	-
26	*Phyllanthus reticulatus*	1	4	-	-	-	-	-	-	-
25	*Launaea procumbens*	1	1	-	2	-	1	-	-	-
23	*Indigofera cordifolia*	1	-	-	-	-	-	-	-	-
22	*Heliotropium calcareum*	2	-	-	-	-	-	-	-	-
1	*Eclipta prostrata*	1	-	1	-	-	-	-	-	-

20	*Corchorus depressus*	1	-	-	-	-	-	-	-	-
19	*Corchorus tridens*	3	-	-	1	-	-	-	-	-
6	*Cyperus articulatus*	4	3	4	1	1	1	1	1	-
38	*Blumea oblique*	-	-	-	1	-	1	-	-	-
33	*Rhynchosia minima*	-	1	-	-	-	1	-	-	-
12	*Indigofera hochstetteri*	2	-	-	-	1	-	-	1	-
7	*Dactyloctenium aegyptium*	2	1	-	-	1	1	-	1	-
5	*Cressa cretica*	3	-	-	-	1	-	-	2	-
4	*Cleome viscosa*	1	-	-	-	1	-	-	-	-
35	*Sporobolus kentrophyllus*	-	1	-	-	-	1	-	1	-
18	*Alternanthera sessilis*	1	-	-	-	-	2	-	-	-
10	*Euphorbia caducifolia*	1	-	-	-	1	2	-	3	-
8	*Eragrostis ciliaris*	-	-	-	1	2	1	2	2	-
64	*Tribulus terrestris*	-	-	-	-	-	-	-	1	-
63	*Senra incana*	-	-	-	-	-	-	-	1	-
62	*Senna holosericea€*	-	-	-	-	-	-	-	1	-
61	*Iphiona grantioides*	-	-	-	-	-	-	-	1	-
60	*Amaranthus graecizans*	-	-	-	-	-	-	-	1	-
59	*Boerhavia procumbens*	-	-	-	-	-	-	-	1	-
58	*Tephrosia strigosa*	-	-	-	-	-	-	-	1	-
57	*Fagonia indica*	-	-	-	-	-	-	-	1	-
53	*Indigofera linifolia*	-	-	-	-	-	-	1	1	-
52	*Digera muricata*	-	-	-	-	-	-	1	1	-
51	*Cometes surattensis*	-	-	-	-	-	-	1	-	-
50	*Cleome scaposa*	-	-	-	-	-	-	1	1	-
49	*Tribulus terrestris*	-	-	-	-	-	1	-	-	-
48	*Polygala erioptera*	-	-	-	-	-	1	-	1	-
47	*Polycarpaea spicata*	-	-	-	-	-	2	-	-	-
46	*Ochthochloa compressa*	-	-	-	-	-	2	2	4	-
45	*Maerua arenaria*	-	-	-	-	-	1	1	-	-
44	*Lycium edgeworthii*	-	-	-	-	-	2	-	-	-
43	*Hibiscus micranthus*	-	-	-	-	-	2	-	-	-
42	*Grewia tenax*	-	-	-	-	-	4	-	-	-
41	*Glossonema varians*	-	-	-	-	-	1	-	-	-
40	*Convolvulus glomeratus*	-	-	-	-	-	1	-	-	-
39	*Cleome brachycarpa*	-	-	-	-	-	1	-	-	-
37	*Blepharis sindica*	-	-	-	-	-	2	3	2	-
36	*Aristida adscensionis*	-	-	-	-	-	1	1	3	-
17	*Zygophyllum simplex*	-	-	-	-	5	-	5	5	-
16	*Trianthema portulacastum*	-	-	-	-	1	-	-	-	-
15	*Trianthema portulacastum*	-	-	-	-	1	-	-	-	-
14	*Tragus roxburghii*	-	-	-	-	1	-	-	-	-
13	*Senna holosericea*	-	-	-	-	3	-	-	-	-
11	*Fagonia indica*	-	-	-	-	1	1	-	-	-
9	*Euphorbia granulata*	-	-	-	-	3	-	-	-	-
3	*Prosopis juliflora*	-	-	-	-	2	-	-	-	-
		0	0	0	0	0	0	0	0	1
		0	0	0	0	1	1	1	1	

3.2.1.5 Biodiversity Index & Species Richness:

I. **α-Diversity** (i.e., the species richness and species diversity within each locality). With reference to species richness, Kinjhar Lake surroundings have shown the highest α-diversity with a total of 41 plant families, 104 genera and 136 species, followed by Chotiari with 40 families, 82 genera, and 116 species, Pai forest with 27 families, 51 genera, and 64 species; and Keti Bunder with 19 families, 32 genera and 39 species.

Among various families, Gramineae exhibited the highest species richness in Kinjhar, Chotiari, and Pai; whereas in Keti Bunder Chenopodiaceae showed the highest diversity followed by Gramineae. This is indicative of the high salinity of the Keti Bunder area. Besides Chenopodiaceae, other halophytes/salt tolerant species include *Avicennia marina, Aeluropus lagopoides, Sporobolus virginicus* and three species of *Tamarix.*

II. **β-Diversity** (i.e., the species turnover from one locality to other locality or diversity between localities)

Localities were compared in pairs with every possible combination. The highest number of species was shared by Kinjhar and Chotiari, i.e., these two localities had 57 species in common, followed by Chotiari – Pai with 30 species in common, Kinjhar-Pai with 30 species in common, Kinjhar-Keti with 27 species in common, and Keti-Chotiari with 13 species in common, and Keti-Pai with 12 species in common.

These localities pairs showed similarity index likewise.

Table 42: Similarity Index and β-diversity of study sites

Localities pairs	Similarity index (CC)	*β-diversity
1. Keti-Kinjhar	0.308	1.691
2. Keti-Chotiari	0.168	1.832
3. Keti-Pai	0.233	1.767
4. Kinjhar-Chotiari	0.452	1.548
5. Kinjhar-Pai	0.30	1.700
6. Chotiari-Pai	0.333	1.667

* Inversely proportional to similarity index.

Only 8 species were found to be shared by all localities, among which the notorious alien species *Prosopis juliflora* was most prominent.

III. **γ- Diversity** (i.e., diversity of all localities collectively).

The total number of species of all the four localities came to be 241. However, this number is liable to increase in future with more detailed surveys in different parts of the year.

3.2.1.6 Significant findings:

- ***Luffa echinata***: According to Flora of Pakistan records, it was considered a rare species recorded only from Chitral, Swat and Tharparkar. However, we have found it to be abundantly present both in Kinjhar (particularly in the part of lake towards Chillia bund) and Chotiari reservoir on small islands.

- ***Populus euphratica***: This species is also recorded for the first time from Kinjhar Lake, where it was found to be abundantly present on small islands in the part of lake towards Chillia bund.

3.2.2 Large Mammals Assessment

FINDINGS OF MAMMALIAN FAUNA SURVEY:

3.2.2.1 SITUATION ANALYSIS:

Three species of Large Mammals belonging to 2 Orders and 4 Families were recorded from the area, as given in Table 43.

Table 43: List of Large Mammals recorded at Kinjhar

S.#	Order	Family	Scientific Name	English Name	Urdu Name	Sindhi Name
1	Artiodactyla	Bovidae	*Sus scrofa*	Wild Boar	Jangli Suar	
2	Carnivora	Canidae	*Canis aureus*	Asiatic Jackal	Geedar	Giddarr
3		Felidae	*Felis viverrina*	Fishing Cat		Mash Billi, Mach Bagral

Besides the above mentioned large mammals, the following species of small sized mammal was also observed.

ORDER: CARNIVORA
FAMILY: HERPESTIDAE

- Common Mongoose *Herpestes edwardsi*

3.2.2.2 Summary of individual Species:

1. Wild Boar *(Sus scrofa)*

Source:http://images.google.com

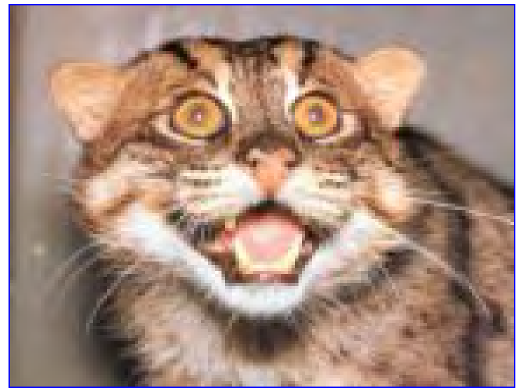
Though the animal is reported by the locals to occur in the area but we could not come across it. It is reported to be living in the marshes with thick reed vegetation.

2. Indian Jackal *(Canis aureus)*

Source:http://images.google.com

It is widely distributed in the area. The animal could be seen with little efforts after dusk on all sides of the lake. It is nocturnal and comes out of its hiding place for feeding. It even comes close to the fishing villages and steals fish for food. Its main diet here is fish. It hides in Lai, Lana and Devi bushes during day time. Three animals were sighted on eastern side of the lake, while indices like their calls were recorded in 40% of the sampled area.

3. Fishing Cat *(Felis viverrina)*



Source: http://images.google.com

The animal is distributed in marshes/swamps in east and north east of the lake, where there is substantial cover of *Saccharum, Typha,* and thick reed beds. One cat was sighted while indirect evidences like footmarks, scats were seen in about 5% of the sampled area.

4. Common Mongoose *(Herpestes edwardsi)*

Mongoose is a small cat like carnivore. This could be seen every where around Kinjhar lake. In the present survey their density was not be estimated but at least 12 mongoose were observed in the sample areas where survey was undertaken. They mainly subsist on rodents but also feed on lizards and insects. The snake charmers trap this animal for showing fight with snakes. This is being a source of livelihood for the snake charmers.

Source: http://imagess.google.com

3.2.3 Small Mammals Survey

FINDINGS OF SMALL MAMMALS STUDY:

3.2.3.1 HABITAT DESCRIPTION

Being a hard soil, the Kinjhar lake area is dominated by the small mammal species adopted for desert conditions. The burrowing mammals are less in number and restricted in the alluvial patches of agricultural lands and along the Indus river bank. The area provides quite diverse habitats for small mammals. It has small hills with loose rocky slabs providing natural homes for non burrowing small mammal's species like *Golunda ellioti* and *Acomys cahirinus*. It has thick vegetation patches in the riparian areas for foxes, porcupine, civits, rabbits and mongooses. It has human settlements for many species like Rattus and Mus and it has open areas for many bat species.

Table 44: Checklist of the Small Mammals found in the Kinjhar Lake Areas

Sr.#	Species	Common Name	Data Source
1	*Manis crassicaudata*	Pangolin	Secondary Data
2	*Tatera indica*	Indian Gerbil	Trapped
3	*Bendicota bengalensis*	Sindh Rice Rat	Trapped
4	*Mus saxicola*	Little Indian Field Mouse	Secondary Data
5	*Mus musculus*	House mouse	Trapped
6	*Rattus rattus*	House Rat	Trapped
7	*Golunda ellioti*	Bush rat	Trapped
8	*Acomys cahirinus*	Spiny mouse	Trapped
9	*Hystrix indica*	Indian crested porcupine	Trapped
10	*Funambulus pennantii*	Norther palm Squirrel	Trapped
11	*Lepus nigricolis*	Indian hare	Trapped
12	*Herpestes edwardsi*	Indian Grey Mongoose	Trapped
13	*Herpestes javanicus*	Small Asian Mongoose	Trapped
14	*Vivericula indica*	Small Indian Civit	Secondary Data
15	*Mellivora capensis*	Honey Badger	Secondary Data
16	*Scotophilus healthii*	Common yellow-bellied bat	Secondary Data
17	*Pipistrellus kuhlii*	Kuhls' bat	Secondary Data
18	*Rhinopoma microphyllum*	Large rat tailed bat	Trapped
19	*Asellia tridens*	Leaf nosed bat	Trapped
20	*Paraechinus micropus*	Indian hedge hog	Trapped

3.2.3.2 BIOLOGICAL INFORMATION OF THE KEY SPECIES:

1. *Tatera indica* (Indian Gerbil)

Biology:

It is the most abundant rodent in the drier areas of Pakistan. It is also the most abundant species in the Chotiari reservoir area. It is a burrowing rodent and has occupied all the flat areas with deep soil in the agricultural fields, along the reservoir banks and in the desert. It is commonly found in the alluvial banks of the agricultural fields and lives in big colonies. It is the most aggressive animal knocking out the other sympatric species like *Gerbillus nanus*. It also has a close association with the *Meriones* species in the desert part of the area.

Behaviour:

It lives in the open areas in shallow burrows with wide holes made usually on the banks of the agricultural fields. During winter season they mainly occupy open areas and shift to close-by shady areas and bushes during the summer season. The species, *Gerbillus nanus* which is sympatric to this species, is knocked out from the open areas to the bushes during the winter season but in the open areas during the summer season.

Habitat requirements:

Alluvial and deep soil usually surrounded by patches of bushes.

Breeding season:

This is highly prolific species and breeds through out the year in the hot environment of the area. There is, however, a bi-modal peak of breeding activity during the spring and monsoon season. Litter size varies from 1-9 with an average of five.

Feed requirements:

It is an omnivorous species eating insects, beetles, grains and leaves of trees but the seeds of crops dominate in their diet.

Distribution in study area

The species *Tatera indica* is one of the most common species in the Chotiari area. As it is the burrowing rodent so it is represented in compact alluvial deep soils and agriculture-desert interface areas, stable sand dunes and woody areas with hard soils where burrowing is possible.

Distribution in Pakistan:

It is found in plain areas of Sindh and Punjab and Chaghi, Kharan, Panjgur and Mekran areas of Balochistan.

Distribution in the World:

It is found in drier regions of India and Sri Lanka. On the western side of Pakistan, it is found in Afghanistan, Iran, Iraq and Syria.

Abundance:
It is one of the most abundant species in the Nara desert.

Significance of the Species:
It is one of the most abundant species in the area. Being a big sized species, it plays an important role in the food chain of any ecosystem. It serves as a food item for mongooses, foxes, cats, rat snakes and cobras.

Status:
Population of this species is quite high in the flat areas and inter-dunal compact areas of desert. It is the most ecologically adaptable species and can intrude in other neighboring areas.

Threats/ Impact assessment:
No any threat can be envisaged to this species.

2. *Bandicota bengalensis* (Indian Mole rat)

Biology:
It is a medium sized rat with semi-naked scaly tail slightly shorter than head and body length. The body fur is hard and coarse and the belly dark Grey. There are four digits on the fore-feet and five digits on the hind feet each bearing a strong claw. The incisors are very broad and smooth on the interior surface without any longitudinal grooves.

Behavior:
The rodent is an active and powerful digger and excavates extensive burrow systems. It is mostly nocturnal and does not tolerate other animal in the same burrow. It stores food grains underground and breeds very rapidly. It is considered a serious agricultural pest. They are not gregarious and are extremely aggressive rodents.

Habitat requirements:
It needs mesic conditions with damp soil for burrowing and prefers embankments around cultivated fields. It avoids sand dune areas or dry rocky regions.

Breeding season:
The bandicoot breeds throughout the year and females bear large litters. Largest litters are recorded from September to November when 14-18 young per litter were common. During rest of the year, 5-10 youngs are produced. It is found that sixty nine young per year are produced by a single female.

Feed requirements:
The principal food of this rodent is rice, succulent shoots of the rice plants, tubers of the grass, seeds of sorghum and millet.

Distribution:
It is found in Sindh, northern and eastern Punjab, parts of Hazara division, Abbotabad, and Peshawar. Outside Pakistan, it is found in India, Sri Lanka, Nepal, Burma, Malaysia and Indonesia.

Abundance:
It is very common species in the cultivated areas of the Chotiari reservoir.

Significance of the Species:
It is the most active and successful species in the cultivated areas of Sindh and Punjab. It is serious agriculture pest and also plays a role in ecosystem as food for the carnivorous species.

3.2.3.3 DISCUSSION

Kinjher Lake is a wildlife sanctuary and hence the importance of small mammals in this area is manifold as they play a vital role in keeping the natural ecological balance in a n ecosystem. The small mammal fauna of the area is quite interesting as three threatened species of small mammals' viz., Common otter (*Lutra lutra)*, Pangolin *(Manis crassicaudata)* and the Honey Badger (*Manis crassicaudata)* are reported to be present in this area. Moreover, four species, *Lepus nigricolis* (Indian Hare), *Herpestes edwardsi* (Indian Grey mongoose)*, Herpestes javanicus (*Small Asian Mongoose*), Vivericula indica (*small indian civit*)* are included in CITES appendix III on the request of India. The area is home of the rare species and also the last eastern limit of the spiny mouse, *Acomys cahirinus*. This species of the rodents is found in Egypt, Saudi Arabia, Iran, and then in Pakistan in the coastal areas of Balochistan and in the Kirther mountains. The river Indus is its eastern most limits for this species and it is nowhere found in the east of Indus River. In the Kinjher area several specimens were caught from a small hill underneath the loose boulders. The area is just on the western bank of the river Indus. In this way that locality can be considered the last eastern limit for the distribution of this species.

The rest of the species of small mammals are common and play their role as either the agricultural pests (*Bandicoota bengalensis, Tatera indica)*, or control the population of insects (Bat species) or serve as food for the foxes, Honey Badgers, Raptors, and other birds. There is always a relationship between the population of small mammals and their prey like foxes and snakes buzzards, owls and raptors. If the population of small mammals is high, the number of their predators increases in the subsequent years. With increase in their number, the population of the small mammals starts decreasing and consequently the holding capacity of the predators' declines. This cycle is repeated after every four to five years.

3.2.4 Reptilian Study

FINDINGS OF THE STUDY:

There are seven important Goths (villages) in this area:

1. Village Abdullah Gandro, Kinjhar lake, Dist. Thatta, Tehsil Thatta
2. Village Hussain Machi, along the lake, outside the bund.
3. Village Adam Katyar, along the lake.
4. Village Haji Jaffar Hillaya, along the lake.
5. Village Haji Soomar Machhi, along the lake.
6. Village Yusuf Hillaya, along the lake.
7. Village Ibrahim Jakro, at Palijani graveyard. (Fish Farm)

The areas of Goth Ibrahim Jakro at Palijani graveyard and fish farm were visited. There is a primary school known as Masjid School which possesses 22 students and two teachers. There we met with a teacher, Mr. Abdur Rahman. He was asked to guide us to Mr. Adam, the liable man of Kinjhar area. Mr. Abdur Rahman took us to Palijani graveyard area. The area has a mixed habitat. Fresh water pond, mountains, hills, sandy muddy and stony area of thick vegetation of *Typha, Saccharam, Tamarix, Acacia, Prosopis, Salvadora, Calotropis and Euphorbia* sp. etc. The place is very suitable for fauna and flora. The area is nearly of 3 sq km. It has a private fish farm. The water is supplied by irrigation department. The condition of pond is quite suitable for fish culture. Nearly all important fresh water fishes are cultured here. This place is situated at nearly 1.5 km from Kinjhar Lake.

During day time, survey was carried out applying method of “One hour plot searching”. A lot of foot prints and tracks of tail of Monitor lizard and dropping of lizards were seen. This thick forest is very suitable place for the shelter and breeding grounds of large and small mammals, lizards and snakes. Large number of frogs, *Euphlyctis cyanophlyctis* (Skittering Frog) and toads, *Bufo stomaticus* (Marbled Toad) were seen in or near water beds. Two lizards, *Calotes versicolor* (Indian Garden Lizard) were seen running and climbing on the *Acacia* and *Prospis* trees.

Following species of lizards of Geckonidae family were moving actively in the field coming from under stone.

Cyrtopodiun kachhensis (Warty Rock Gecko)

Cyrtopodiun scaber (Keeled Rock Gecko)
Hemidactylus brooki (Spotted Indian House Gecko)
Hemidactylus flaviviridis (yellow – Bellied House Gecko)
Hemidactylus leschenaulti (Bark Gecko)

These geckos are the preferred food of snakes. Also three Monitor lizards, *Varanus bengalensis* (Indian Monitor Lizard) were seen resting under the large stones. We climbed the hill and soon found a viper, *Echis carinatus sochureki* (Saw – Scaled Viper) resting on the way. After 10 minutes on the same track another saw – scaled viper was seen creeping slowly. It was captured for the collection and record. The habitat of hilly area with thick and thin *xerophytic* bushes especially *Euphorbia* sp is very suitable for the shelter and breeding ground of snakes especially for cobra and saw – scaled viper. According to local guide, and also through personal observation, *Echis carinatus sochureki* (Saw – Scaled Viper) is abundant in this area. So within the night study of 5 –

6 hours, seven (7) saw – scaled vipers were observed within one sq km area of this habitat.

Table 45: Checklist of Reptilian and Amphibian Fauna of Kinjhar Lake

REPTILES

S. No.	Family	Species	English Name	Local Name	Status
1.	Agamidae	*Calotes versicolor versicolor*	Indian Garden Lizard	Girgit or Girgitan, Shyee, Kafir Girgit	Common
2.		*Trapelus agilis agilis*	Brilliant Agama	Karrun	Common
3.		*Trapelus megalonyx*	Afghan Ground Agama	Karrun	Common
4.	Eublepharidae	*Eublepharis macularius*	Fat-tailed Gecko	Hun – Khun	Less Common
5.	Gekkonidae	*Cyrtopodion kachhensis kachhensis*	Warty Rock Gecko	Chuggul	Common
6.		*Cyrtopodion scaber*	Keeled Rock Gecko	Chuggul	Common
7.		*Hemidactylus brookii…*	Spotted Indian House Gecko	Chhipkali, Chiplee, Chuttee	Common
8.		*Hemidactylus flaviviridis*	Yellow-Bellied House Gecko	Chhipkali, Chiplee, Chuttee	Common
9.		*Hemidactylus leschenaultii*	Bark Gecko	Chhipkali, Chiplee, Chuttee	Common
10.	Lacertidae	*Acanthodactylus cantoris*	Indian Fringe-Toed Sand Lizard	Chhipkali, Chiplee, Chuttee	Common
11.		*Ophiosops jerdonii*	Punjab Snake-eyed Lacerta	Chhipkali, Chiplee, Chuttee	Common
12.	Uromastycidae	*Uromastyx hardwickii*	Indian Spiny-tailed Lizard	Sandha, Sonder	Appendix II in CITES. Common in Pakistan
13.	Varanidae	Varanus bengalensis	Indian Monitor	Goh or Goh-Pard	Appendix I in CITES, Common

14.	Boidae	*Eryx conicus*	Russell's Sand Boa	Do-moi, Do-sar	Less Common
15.	Colubridae	*Coluber fasciolatus*	Banded Racer	Sagi, Dhari wala saanp	Less Common
16.		*Lycodon striatus striatus*	Northern or Spotted Wolf Snake	Aabi Sangchul	Less Common
17.		*Oligodon taeniolatus*	Streaked Kukri Snake	Kukri	Less Common
18.		*Platyceps rhodorachis rhodorachis*	Cliff Racer	Sagi, Jhari wala Saanp	Common
19.		*Platyceps ventromaculatus ventromaculatus*	Glossy-bellied Racer	Sagi, Jhari wala Saanp	Common
20.		*Psammophis leithi*	Pakistan Ribbon Snake or Ribbon Snake	Tormar or Thormar	Less Common
21.		*Psammophis condanarus*	Indian Sand snake	Tormar or Thormar	Less Common
22.		*Ptyas mucosus*	Dhaman or Rope Snake	Dhaman	Common
23.		*Spalerosophis diadema atriceps*	Royal Snake	Kourar	Common
24.	Elapidae	*Bungarus caeruleus caeruleus*	Indian or Common Krait	Sangchul, Pee – un	Common
25.		*Naja naja*	Indian Cobra or The Cobra	Kala Naag, Naagu, Chamcha Maar	Common
26.		*Naja oxiana*	Oxus Cobra or Brown Cobra	Kala Naag, Naagu, Chamcha Maar	Endangered, included in Red Data List
27.	Viperidae	*Daboia russelii russelii*	Russel's Viper or Chain Viper	Koriala, Khuppar	Common
28.		*Echis carinatus sochureki*	Eastern or Sochurek's Saw-scaled Viper	Loondee, Jalebi, Khuppar	Common
29.	Trionychidae	Lissemys punctata	Indian Flap-shell Turtle	Kachwa	Less Common, Appendix I in CITES

AMPHIBIANS

S. No.	Family	Species	English Name	Local Name	Status
1.	Ranidae	Euphlyctis cyanophlyctis cyanophlyctis	Skittering Frog	Daddu	Common
2.	Bufonidae	Bufo stomaticus	Marbled Toad	Daddu	Common

3.2.5 Ichthyological Survey

FINDINGS OF THE FISH SURVEY:

Kinjhar Lake is formed by the union of two lakes, Kalri and Sonehri. It provides livelihoods to thousands of fishermenwho have settled on the banks ‘of the lake for hundreds of years and their only source of livelihood is fishing in the lake. Gandra is the clan of fishermen whose leader was Keenjhar (on whose name Keenjhar is called so). Before the construction of link canal (bypassing the lake and directly connecting the K. B. Feeder to Karachi canal) about forty thousands fishermen were living around the Keenjhar in twelve villages. They had four main fish landing centers including Sonhri, Jhumpir, Chilya, and Khambo where the fish was landed to go to the market. Fishermen lived a happy and prosperous life. At that time there were one thousand seven hundred fishing boats and several hundred copper-pitchers. Throughout the world there is no other example that fishermen perform the fishing activity by putting the copper-pitcher beneath their abdomen, it shows the artistry of Keenjharite fishermen. It was very useful for individual fishing and economical in the absence of fishing boats, however, after the constriction of link canal and continuous shortage of water there has been a gradual reduction in the population of fishermen communities as well as the production of the fish.

Table 46: Fisheries Resources of the Kinjhar Lake

Sr.#	Species	Family	Local Name	Commercial value	Status	Feeding Habits
1	*Tenualosa ilisha*	Clupeidae	Pullo	High	Rare	
2	*Notopterus notopterus*	Notopteridae	Gandhni	Medium	Common	Carnivore
3	*Chitala chitala*	Notopteridae	Gandhan	High	Less common	Carnivore
4	*Chela cachius*	Cyprinidae		Low	Common	Herbivore
5	*Salmophasia bacaila*	Cyprinidae	Sanota	Low	Common	Herbivore
6	*Securicula gora*	Cyprinidae		Low	Common	Herbivore
7	*Amblypharyngodon mola*	Cyprinidae		Low	Common	Herbivore
8	*Aspidoparia morar*	Cyprinidae		Low	Common	Herbivore
9	*Barilius vagra*	Cyprinidae		Low	Common	Herbivore
10	*Rasbora daniconius*	Cyprinidae		Low	Common	Herbivore
11	*Cirrhinus mrigala*	Cyprinidae	Mirgal, Morakhi	High	Common	Herbivore
12	*Cirrhinus reba*	Cyprinidae	Ganer	Medium	Common	Herbivore
13	*Gibelion catla*	Cyprinidae	Theli	High	Common	Herbivore
14	*Labeo calbasu*	Cyprinidae	Dahi	High	Common	Herbivore
15	*Labeo dyocheilus pakistanicus*	Cyprinidae		Medium	Common	Herbivore
16	*Labeo gonius*	Cyprinidae	Sario	Medium	Common	Herbivore
17	*Labeo rohita*	Cyprinidae	Ruhu, Kurro	High	Common	Herbivore
18	*Labeo dero*	Cyprinidae		Medium	Common	Herbivore
19	*Osteobrama cotio*	Cyprinidae	Makhni	Low	Common	Omnivore
20	*Puntius sophore*	Cyprinidae	Popri	Low	Common	Herbivore
21	*Puntius ticto*	Cyprinidae	Popri	Low	Common	Herbivore

Sr.#	Species	Family	Local Name	Commercial value	Status	Feeding Habits
22	*Puntius chola*	Cyprinidae	Popri	Medium	Common	Herbivore
23	*Systomus sarana*	Cyprinidae	Khirni	Low	Common	Herbivore
24	*Crossocheilus diplocheilus*	Cyprinidae		Medium	Common	Herbivore
25	*Cyprinus carpio*	Cyprinidae	Carp	High	Common	Herbivore
26	*Ctenopharyngodon idella*	Cyprinidae	Grass	High	Common	
27	*Aristichthys nobilis*	Cyprinidae		High	Common	Herbivore
28	*Hypophthalmichthys molitrix*	Cyprinidae		High	Common	Herbivore
29	*Sperata sarwari*	Cyprinidae	Seenghar o	High	Common	Piscivore
30	*Mystus cavasius*	Bagridae	Tengra	Low	Common	Carnivore
31	*Mystus bleekri*	Bagridae	Tingaran	Low	Common	Carnivore
32	*Rita rita*	Sisoridae	Kago	High	Rare	Carnivore
33	*Bagarius bagarius*	Sisoridae	Barim	High	Less common	Piscivore
34	*Ompok bimaculatus*	Siluridae	Pafta	Low	Common	Carnivore
35	*Wallago attu*	Siluridae	Jerki	High	Common	Piscivore
36	*Heteropneustes fossilis*	Heteropneusti dae	Loora	Medium	Common	Carnivore
37	*Clupisoma garua*	Chilbeid.ae	Dongna	High	Less common	Carnivore
38	*Clupisoma nazeeri*	Chilbeid.ae	Dongna	High	Less common	Carnivore
39	*Xenentodon cancila*	Xenentodonti dae	Kang	Medium	Very common	Carnivore
40	*Channa marulia*	Channidae	Sole	High	Common	Carnivore
41	*Channa punctata*	Channidae	Shakur	Medium	Common	Carnivore
42	*Chanda nama*		Kandar	Medium	Very common	Omnivore
43	*Parambasis baculis*		Kandar	Low	Very common	Omnivore
44	*Parambasis ranga*		Kandar	Low	Very common	Omnivore
45	*Glossogobius giuris*	Gobidae	Gulla	Medium	Common	Carnivore
46	*Oreochromis mossambicus*		Daya	High	Very common	Omnivore
47	*Mastacembelus armatus*	Mastace.mbel idae	Goj	Medium	Very common	Carnivore
48	*Macrognathus pancalus*		Goj	Medium		Carnivore

Cirrhinus mrigala

Catla catla

Heteropneustes fossillis

Channa punctata

Notopterus notopterus

Xenentodon cancila

Labeo dero

Tilapia mosambiqa

3.2.6 Avi Fauna Survey

FINDINGS OF THE AVI FAUNA SURVEY:

A total of 44 species of birds were observed over the two surveys. The initial survey carried out in September 2006, mostly on boat though a few transects of neighboring wetlands were also taken. The survey was carried out taking the route from its eastern side to west and north western side to south and then towards the south eastern side of the lake .The expected population of water birds was not present and the condition of the lake was disappointing. A second survey was conducted on 14th Dec 2006 produced most of the observations from the lake. The most potential side of the lake area is located at south-eastern side of the lake where a fresh water lagoon can be found supporting a variety of birds throughout the year.

No duck was seen due to the high water level and also perhaps the temperature of September was quite high and therefore probably not suitable for the birds to penetrate the fresh water areas. Presence of waders (as seen at Keti Bunder) at coastal areas also revealed that birds are first reaching coastal areas rather than inland water masses. A possible cause of their poor representation in the fresh water bird populations could be the extreme disturbance that is prevailing throughout the project site.

Table 47: List of birds recorded from Kinjhar Lake

S.No	English name	Scientific name	Population estimation	Status
1	Little grebe	Tachybaptus ruficollis	10-50	Resident
2	Little Cormorant	*Phalacrocorax niger*	350-400	Resident
3	Large Cormorant	*Phalacrocorax carbo*	10-50	Migrant
4	Indian Shag	*Phalacrocorax fuscicollis*	10-50	Migrant
5	White Pelican	*Pelicanus onocrotalus*	<10	Migrant
6	Grey Heron	*Ardea cinerea*	<10	Resident
7	Purple heron	*Ardea purpurea*	<10	Resident
8	Pond Heron	*Ardeola grayii*	150-200	Resident
9	Little egret	*Egretta garzetta*	350-400	Resident
10	Intermediate Egret	*Egretta intermidea*	10-50	Resident
11	Large Egret	*Egretta alba*	10-50	Resident
12	Cattle egret	*Bubulcus ibis*	450-500	Resident
13	Night Heron	*Nycticorax nycticorax*	10-50	Resident
14	Common coot	*Fulica atra*	550-1000	Migrant
15	Shoveller	Anas clypeata	100-150	Migrant
16	Mallard	*Anas platyrhynchos*	150-200	Migrant
17	Garganey	*Anas querquedula*	50-100	Migrant
18	Pintail	*Anas acuta*	10-50	Migrant
19	Common Teal	*Anas crecca*	250-300	Migrant
20	Widgeon	*Anas penelope*	10-50	Migrant
21	Common Pochard	*Aythya ferina*	2500-3000	Migrant
22	Tufted duck	*Aythya fuligula*	50-100	Migrant
23	Gad wall	*Anas strepera*	10-50	Migrant
24	Purple Gallinule	*Porphyrio porphyrio*	10-50	Resident
25	Gallinule	*Gallinula Chloropus*	10-50	Resident
26	Whit breasted Water Hen	*Amaurornis phoenicurus*	<10	Resident

27	Little tern	*Sterna albifrons*	100-150	Resident
28	River Tern	*Sterna auratia*	150-300	Resident
29	Black-bellied Tern	Sterna acuticauada	50-100	Migrant
30€	Whiskered Tern	*Sterna hybridus*	10-50	Migrant
31	Black Headed gull	*Larus rudibundus*	400-450	Migrant
32	Lesser Black-Backed Gull	*Larus fuscus*	10-50	Migrant
33	Black winged Stilt	*Himantopus himantopus*	10-50	Resident
34	Red wattled lapwing	*Vanellus indicus*	<10	Resident
35	Green Sandpiper	*Tringa ochropus*	10-50	Migrant
36	Common Sand piper	*Actitis hypoleucus*	10-50	Migrant
37	Pheasent Tail jacana	*Hydrophsianus chirurgus*	<10	Resident
38	Little Ringed plover	*Charadrius dubius*	<10	Migrant
39	Little Stint	*Calidris minuta*	10-50	Migrant
40€	Common King fisher	*Alcedo athis*	<10	Resident
41	Pied King Fisher	*Ceryle rudius*	10-50	Resident
42	White breasted King Fisher	*Halcyon smyrnensis*	<10	Resident
43	Swallow	*Hirundo rustica*	400-450	Migrant
44	Green Bee eater	*Merops orientalis*		Resident

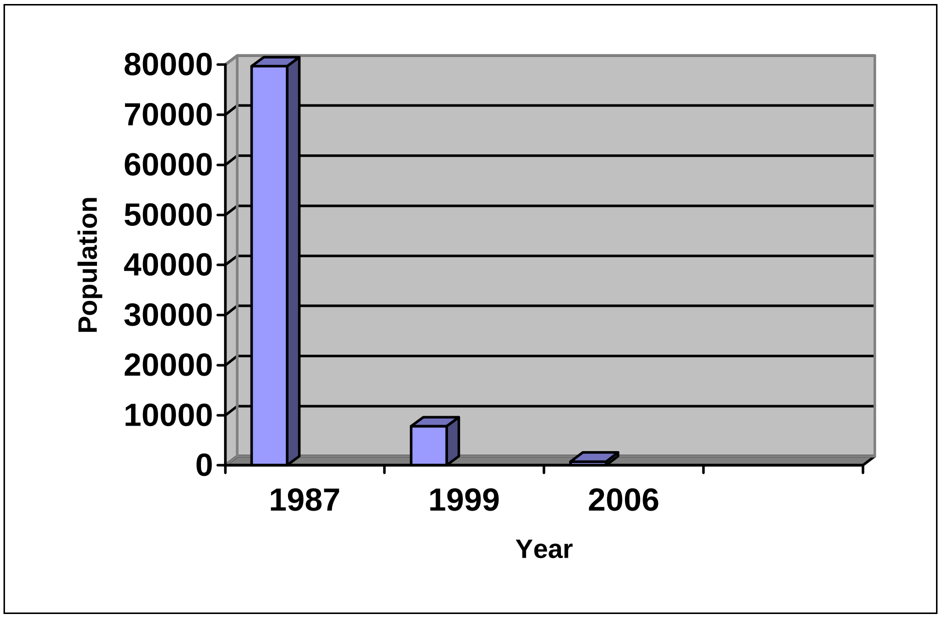
A total of 22 resident birds were observed and the remaining 22 were identified as migratory species. Most of the sightings were made from the main lake or the outer swamps and freshwater marshes.

Image 4: Population of Pochard in the Kinjhar main lake area

Images 5 – 8: Various habitats at Kinjhar Lake

It was found that there is considerable reduction in population of Coot at Kinjhar in comparison to the countings made by Koning in 1987, as shown in the graph given below:

Fig 8: Change in population of Coot at Kinjhar Lake



Most of the species were observed in deeper water except for the waders who were confined to the shallows. The population of ducks was relatively moderate and Pochard was the predominant species comprising of about 2835 birds. There were nine species of ducks representing 3,522 birds whilst there were only 750 coots were recorded during the survey. This is a severe decline in bird population since 1987 when 79,670 coots were counted by Koning. Incidentally, the local fisherman stated that there were thousands of coots present in the lake area just three days before the survey. The main population of ducks was observed near the Noori tomb where water depth was more then sixteen feet. The coot population usually feed in shallow water area but roost in the deep water as well; therefore they are usually hunted during the feeding time whilst duck species usually manage to escape to safety to deep water area.

The population of pheasant-tailed Jacana as well as Plover and Sandpiper species have also declined due to the disturbance and reduction in shallow areas of the lake.

No pelican was observed within the outer area of the lake but the little cormorants and Indian shag were sighted. The pygmy cormorant was not sighted at both sites and the Darter seems to have become absent from the lake.

Figure 9: Population variation of Ardeidae family at Kinjhar Lake (2006).

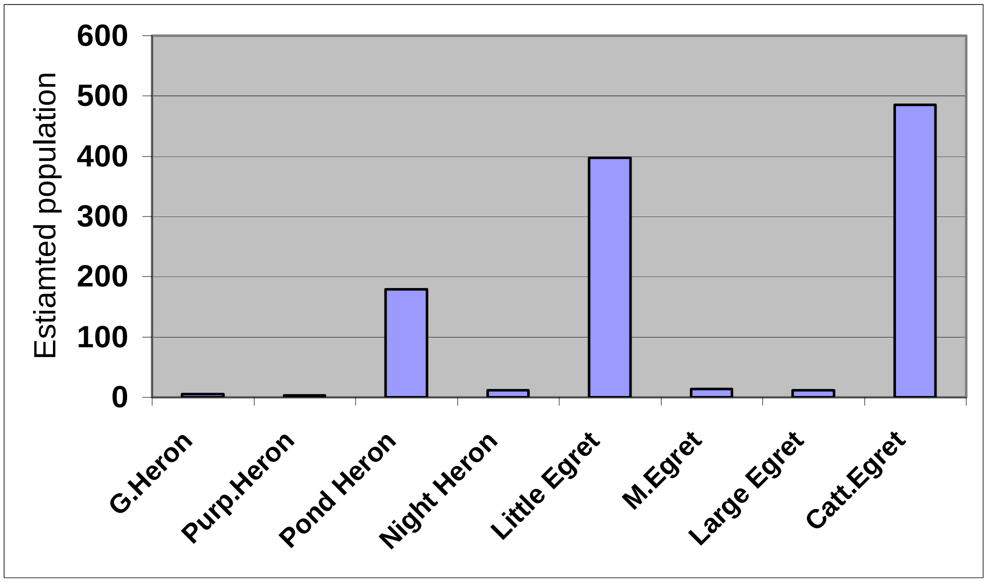
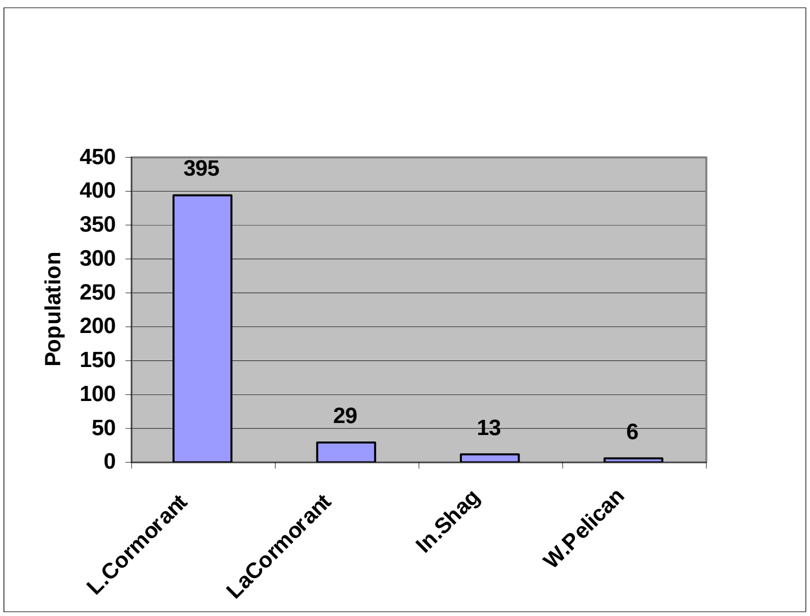


Fig 10: Population variation in species of Cormorants and Pelican



Eight species of the family Ardeidae were observed. Unfortunately due to lack of time Bitterns species could not be observed due to their nocturnal nature. No Spoon bills or Flamingos were seen though these birds are reported from the lake area. The populations of egrets and herons were also unusually low, perhaps indicating a decline in the populations (especially Purple Heron and Grey Heron) in the Sindh Province. Only five Grey herons and only 3 Purple herons were seen in the lake area.

The population of large sized egrets and herons, except the night heron which is nocturnal species, seem also to be on the decline, perhaps due to several reasons such as reduction in available breeding and nesting sites in or around the lake area and secondly the increasing hunting pressure. It is pertinent to note that no nest was found in or around the lake during the surveys.The outer margins swamps and fresh water were also surveyed and though a good number of birds were observed, many of the species such as waders *(Tringa spp.)* Glossy ibis and white breasted water hen were absent.

Table 48: List of birds recorded from the freshwater marshes of Kinjhar Lake

S.No	Common name	Scientific name	Population estimation	Status
1	Little grebe	*Tachybaptus ruficollis*	100-150	Resident
2	Little Cormorant	*Phalacrocorax niger*	550-1000	Resident
3	Large Cormorant	*Phalacrocorax carbo*	10-50	Migrant
4	Indian Shag	*Phalacrocorax fuscicollis*	10-50	Migrant
5	Grey Heron	*Ardea cinerea*	<10	Resident
6	Purple Heron	*Ardea purpurea*	<10	Resident
7	Pond Heron	*Ardeola grayii*	50-100	Resident
8	Little egret	*Egretta garzetta*	100-150	Resident
9	Large Egret	*Egretta alba*	<10	Resident
10	Cattle egret	*Bubulcus ibis*	50-100	Resident
11	Night Heron	*Nycticorax nycticorax*	<10	Resident
12	Pin tail	*Anas acuta*	10-50	Migrant
13€	Common Teal	*Anas crecca*	300-350	Migrant
24	Purple Gallinule	*Porphyrio porphyrio*	10-50	Resident
25	Gallinule/Moorhen	*Gallinula Chloropus*	10-50	Resident
26	Whit breasted Water Hen	*Amaurornis phoenicurus*	<10	Resident
27	Redwatlled lapwing	*Vanellus indicus*	10-50	Resident
28	Black winged stilt	*Himantopus himantopus*	150-200	Resident
35	Green Sandpiper	*Tringa ochropus*	10-50	Migrant
36	Common Sand piper	*Actitis hypoleucus*	50-100	Migrant
37	Pheasant-tailed Jacana	*Hydrophsianus chirurgus*	10-50	Resident
38	Little Ringed plover	*Charadrius dubius*	100-150	Migrant +
39	Little Stint	*Calidris minuta*	150-300	Migrant
40	Common King fisher	*Alcedo atthis*	10-50	Resident
41	Pied King Fisher	*Ceryle rudis*	10-50	Resident
42	White breasted Kingfisher	*Halcyon smyrnensis*	*10-50*	Resident
43	Swallow	*Hirundo rustica*	*400-450*	Resident
44	Sand martin	*Riparia riparia*	*150-200*	Resident
45	Glossy Ibis	*Plagadis falcinellus*	*10-50*	Migrant
46	Marsh Sand Piper	*Tringa stgnatilis*	*<10*	Migrant
47	Red Shank	*Tringa totanus*	*50-100*	Migrant

The habitat of the outer area of the lake is still ideal for the water birds but the disturbance due to human interference is one of the causes of the less population of birds in the area.

During the second survey, undertaken in December, there were some additional species that were not recorded earlier. This include Spot bill duck, Greater Flamingo, Spoonbill, two species of whistling ducks, Marbled Teal, Cotton Teal and Common Shelduck.

3.2.7 Limnological Study

FINDINGS OF THE LIMNOLOGICAL STUDY:

3.2.7.1 Water sample analysis:

The survey was conducted in November 2006. Salinity was recorded as 0.10 ppm, pH between 7.1 -7.2, Total Dissolved Solids ranges between 136-138 mg/L, Total Suspended Solids ranged between 840-857 mg/L, Biochemical Oxygen Demand between 130-134 mg/L, Chemical Oxygen Demand between 168-182 mg/L, Phenol values ranges between 0.025-0.029 mg/L, Nitrate between 0.98-1.84 mg /L, Cadmium and no Chromium was found nil in the samples. Oil and Grease value obtained as 259 mg/L. (Table 47)

Microbiological analysis shows the values of total coliforms were $\geq$ 2400, total faecal coliform $\geq$ 2400 and total faecal streptococci was < 3. (Table 48)

Commercially used *pesticide* results depicted as negative for Malathione, Cypermetherine, Aldrin Dialdrin for three sites viz, Kinjhar lake, Chotirai reservoir and Keti Bunder (Table48 A). But the further analyses were done and positive results were obtained for the following pesticides at 3 sites which were Acetempride at Keti Bunder and Chotiari Reservoir whereas Myalin was detected at Keti Bunder (Table 48 B)

3.2.7.2 Planktons:

- **Phytoplanktons**: The phytoplanktons are identified from the samples belonging to the phyla of Chlorophyta, Cyanophyta and Euglenophyta, 17 species belonging to Phylum Cyanophyta (Cyanobacteria) identified from Kinjhar Lake. Four species identified from the order Nostocales These species are of genus *Anabaena*, *Merismopedia* and *Microcystis* and *Oscillatoria* commonly referred as toxic (Table 49). These genera are responsible for gastro-intestinal illnesses. The presences of these species in drinking water are being recognized as potential hazards to the health of human being (Mahar *et al*., 2000). The excess growth of these genera may probably be due to the enrichment of the hardness ($CaCO_3$), nitrates, and phosphates. The second main reason is the human activities and decomposition of organic matter. Seven species belonging to the Phylum Chlorophyta and 1 species belonging to Euglenophyta were observed.
- **Zooplanktons**: Two phyla of zooplanktons were identified from the samples which were Rotifera and Arthopoda. Among which the cladocera was dominant followed by cyclopoida. There was 1 genera of rotifera recorded in the samples whereas 9 genera recorded from arthopoda (Table 50). Overall 12 species recorded from the samples.

3.2.7.3 Macro invertebrates:

Two species of mollusks (dead shells) were identified from the muddy and sedimentary samples. (Table 51)

Table 49: Physical & Chemical parameter analysis at Kinjhar Lake:

Parameters mg/L	Sampling Stations					NEQS (Rev)mg/l
Physical parameters	**ST-1**	**ST-2**	**ST-3**	**ST-4**	**ST-5**	
pH	7.2	7.1	7.1	7.2	7.1	6-9
Temperature ^{o}C	26.10	25.60	25.60	26.80	26.40	40 =<3 ^{o}C
Salinity $^{0}/_{00}$	0.10	0.10	0.10	0.10	0.10	
Total dissolved solids (TDS)	136	138	138	138	138	3500
Total suspended solids (TSS)	852	840	857	842	835	200
Chemical parameters						
Biochemical oxygen demand (BOD_5)	130	132	135	130	134	80
Chemical oxygen demand (COD)	168	172	176	175	182	150
Phenol	0.025	0.029	ND	ND	ND	0.1
Nitrate	1.12	0.98	1.15	1.67	1.84	50
Cadmium (composite)	Nil	ND	ND	ND	ND	0.1
Chromium (composite)	Nil	ND	ND	ND	ND	1.0
Oil and grease (n-Hexane extract (composite)	259	ND	ND	ND	ND	10

Table 50: Microbiological analysis at Kinjhar Lake:

Parameter MPN/100ml	Samples	WHO Guideline
Total Coliforms	≥2400	<3
Total Faecal coliform	≥2400	<3
Total Faecal streptococci	<3	<3

Table 50 A: Pesticide analysis:

Sampling Site	Pesticide µg/L (BDL)			
	Malathione	Cypermetherine	Aldrin	Dialdrin
Keenjhar lake	-ve	-ve	-ve	-ve
Keti Bunder	-ve	-ve	-ve	-ve
Chotiari Reservoir	-ve	-ve	-ve	-ve

Table 50 B: Pesticide analysis:

Sampling Site	Pesticide µg/L (BDL)		
	Acetempride	Acetempride	Myaline
Keenjhar lake	-ve	-ve	-ve
Keti Bunder	+ve	-ve	+ve
Chotiari Reservoir	-ve	+ve	-ve

BDL= Below Detection Limit
+ve = Present
-ve = Absent

Table 51: Checklist of Phytoplankton (algae) recorded at Kinjhar Lake.

Stations	1	2	3	4	5
Phylum: Cyanophyta					
Class: Chroocophyceae					
Order: Chroococcales					
Family: Chroococcaceae					
Aphanothece caldariorum Richter, P.	-	+	+	-	-
Aphanothece saxicola Nag.	+		+	-	-
Chroococcus minor (Kutz) Nag.	-	+	-	+	+
Chroococcus minutus (Kutz.)Nag.	-	-	-	-	+
Coelosphaerium dubium Grun.	+	-	-	+	+
Cylindrospermum staganale Kutz.	+	-	+	-	-
Merismopedia glauca Rao.	+	-	+	-	-
Merismopedia minima Beck.	+	+	+	+	+
Microcystis aeruginosa f. (sphaerodictyoides Elen)	+	+	+	+	+
Microcystis aeruginosa Kutz.	+	+	-	-	+
Microcystis aeruginosa v. major	+	-	+	-	+
Microcystis elabens (Berb.)Kutz.	-	+	-	+	+
Microcystis flos-aquae (Wittr)Kirchn.	-	+	-	+	+
Microcystis incerta Lemm.	-	+	+	+	+
Microcystis leavens Bret Kutz.	+	+	+	+	+
Microcystis pseudofilamentosa Crow.	-	-	+	-	+
Microcystis robusta (Clark) Nygaard.	+	+	+	+	+
Class: Nostocophyceae					
Order: Nostocales					
Family: Nostocaceae					
Anabaena plantonica Brunnthaler	+	+	+	+	-
Anabaena variabilis Kuetzing	+	-	+	-	-
Family: Oscillatoriaceae					
Oscillatoria jasorvensis Vouk.	-	-	+	+	+
Spirulena princeps W.et G.S. West	+	+	+	-	-
Stations	**1**	**2**	**3**	**4**	**5**
Phylum:Chlorophyta					
Class: Chlorophyceae					
Order: Chlorococcales					
Family: Hydrodictyaceae					
Coelastrum microporum Nag.	+	+	-	-	-
Pediastrum clathratum (Schroeter) Lemm.	-	-	-	+	+
Pediastrum simple v. duodenarium ((Bail.) (Rabenh.)	+	-	-	-	+
Pediastrum sp.	+	+	-	-	+
Pediastrum sp.	+	-	-	-	-
Pediastrum sp.	+	+	-	-	-
Golenkinia radiata Chod.	+	+	-	-	-

Phylum: Euglenophyta					
Class: Euglenophyceae					
Order: Euglenales					
Family: Euglenaceae					
Gloeomonas ovalis Klebs.	-	-	-	-	+

(-)Absent
(+) Present

Table 52: Checklist & population of Zooplanktons recorded at Kinjhar Lake.

Stations	1	2	3	4	5
Phylum: Rotifera					
Class: Monogonota					
Order: Ploima					
Family: Brachionidae					
Brachionus forficula	0	6	8	3	0
Brachionus falcatus	9	0	25	4	2
Brachionus diversicornis	9	0	0	0	1
Phylum: Arthropoda					
Class: Crustacea					
Order: Copepoda					
Suborder: Cyclopoida					
Thermocyclops hyalinus	23	4	29	5	3
Mesocyclops leuckerti	2	0	9	0	11
Cyclops nupli	3	0	7	0	0
Suborder: Calanoida					
Family: Diaptomidae					
Heliodiaptomus sp.	14	4	5	0	44
Suborder: Cladocera					
Family: Chydoridae					
Alona karua	2	6	1	1	0
Family: Bosminidae					
Bosmina longirostris	4	34	5	67	21
Family: Daphnidae					
Ceriodaphnia cornuta	35	2	56	0	7
Simocephalus expinosus	0	8	52	1	0
Family: Sididae					
Diaphnosoma sarsi	0	6	0	0	0

Table 53: Checklist of zoo benthos (Dead shells of mollusks) recorded at Kinjhar Lake.

Stations	1	2	3	4	5
Phylum: Mollusca					
Class: Gastropoda					
Subclass: pulmonata					
Order: basommatophora					
Family: Lymnaeidae					
Tricula cristella (Gredler)	-	-	2	-	-
Gyraulus convexiusculus (Hutton)	-	-	-	-	1

(-)Absent
(+) Present

3.2.7.4 Discussion

Phytoplankton and zooplankton are two of the common biological parameters collected because they form the base of the aquatic food web and influence other aspects of the aquatic ecosystem including color and clarity of the water and fish production. Phytoplanktons are microscopic plants that are an integral part of the aquatic ecosystem. They use nutrients in the water and sunlight to grow and are the base of aquatic food web. Zooplanktons are tiny animals that feed on phytoplankton and zooplankton. They are vital to the aquatic ecosystem and form the second level in the food web. The quantity and quality of phytoplankton is a good indicator of water quality. The high relative abundance of chlorophyta is indicative of productive water.

In this present baseline study the aquatic habitat assessment was focused to the planktons and macro biota with physico chemical analysis of water. The diversity index and relative abundance were used to determine the water quality and overall situation for other aquatic fauna and flora of Kinjhar Lake, Chotiari reservoir and Keti Bunder.

- **Water quality:**

During the survey the pH was within the range of 7 which is also acceptable. The water quality was alkaline in nature *i.e.* more basic. As pH of water is important because many biological activities can occur only within a narrow range (Shepherd & Bromage, 1992). Oxygen plays very important role in determining the potential biological quality of water (Lloyd 1992). In the present study, the high value of Biological Oxygen Demand indicates the non suitable environment for the aquatic life in three sites (Table 47). Phenol and its derivatives which are present in many industrial effluents must be specifically treated because of their toxicity to the aquatic life and ecosystems.

The high value of total suspended solids indicating the excessive amount of organic matter which is not suitable for the aquatic life. The low values of chromium and cadmium indicting the water is not contaminated by heavy metals. Acceptable amount of phenol is present in the study areas.

Oil and grease present in the water samples are in high values which may be due to the mechanized boats used in the three sites (Table 47).

Pesticides

Pesticides that are soluble in both water and fats are usually taken up more quickly by humans and animals as the traces of these pesticides along with their metabolites and break down products are ubiquitously present in abiotic and biotic environment (Tiel 1972). Negative results for commercially used pesticides shows that the there are no traces of commercially exploited pesticides in the three sites (Annexure 2).

Microbiological Analysis:

In Kinjhar Lake the highly contaminated results were obtained for microbiological point of view. The presence of total coliforms and total faecal coliforms showed the highly pathetic drinking water quality. The Kinjhar Lake supplies the drinking water to the Mega city of Karachi. This will need further investigations for the presence of microbiological organisms in the drinking water.

- **Relative Abundance:**

The Zooplanktons were abundant as compared to phytoplankton during the study at Kinjhar Lake. The R.A % of phytoplankton was calculated as 13.2 % and for zooplankton it was 86.8 %. The cynophyta was dominant followed by chlorophyta and euglenophyta (Table 52 & 53 Figure 11, 12 & 13). The R.A of *Tricula cristella* is higher among the macro invertebrates which is 40% followed by 20% of *Gyraulus convexiuxculus*).The R.A of *Lymnaea stagnails* for macro invertebrates was 40% (Table 54).

- **Diversity Indices:**

Diversity indices are good indicator of pollution in aquatic ecosystem (Mason 1998). The values are less than 1 indicating the polluted condition as described by Mason (1988). The values in the range of 1-3 are characteristics of moderately polluted conditions and values less than 1 characterize heavily polluted condition and the value greater than 3 indicates the clean water and good for biological life.

The water quality for phytoplankton is good for the growth of Cynophyta whic is toxic in nature. Similarly the water condition for Chlorophyta and Euglenophyta are highly polluted. In zooplankton the water condition is not ideal for its growth.

Table 54: Diversity Index and Relative Abundance recorded at Kinjhar Lake

Phyla of Planktons Recorded	No. of Genera – (S)	Total # of individuals (N)	In N	Diversity Index = S-1/ In N	Relative Abundance R.A = # of individuals x 100 Total #
Phytoplankton					
Cynophyta	9	65	4.17	1.91	82.27%
Chlorophyta	3	13	2.56	0.78	16.45%
Euglenophyta	1	1	0	0	1.2%
Total		**79**			
Zooplanktons					
Ploima (Rotifera)	1	52	4	0	9.9%
Cyclopoida (Arthopoda)	3	96	5	0.4	18.35%
Calnoida (Arthopoda)	1	67	4.20	0	12.81%
Cladocera (Arthopoda)	5	308	5.73	0.69	58.89%
Total		**523**			
Total number of planktons		**602**			

Table 55: Relative Abundance of Phytoplankton and Zooplankton occurring at Kinjhar Lake.

	Kinjhar Lake
Number of Phytoplankton	79
Number of Zooplankton	523
Total Number of Organisms	602
R.A of Phytoplankton %	13.2%
R.A of Zooplankton %	86.8%

Table 56: Relative Abundance of Macrofauna at Kinjhar Lake.

S.No.	Classification Kinjhar Lake		No. of individuals	Relative Abundance % R.A = # of individuals / Total # of individuals x 100
	Phyllum Class Sub class Order Family Genus	MOLLUSCA GASTROPODA PLUMONATA BASOMMATOPHORA LYMNAEIDAE Tricula		
1	**Species**	***Tricula cristella* (Gredler)**	2	66.6%
	Phyllum Class Sub class Order Family Genus	MOLLUSCA GASTROPODA PLUMONATA BASOMMATOPHORA LYMNAEIDAE Gyraulus		
2	**Species**	***Gyraulus convexiuxculus***	1	33.33%
Total			3	

Figure 11: Relative Abundance of Phytoplankton at Kinjhar Lake

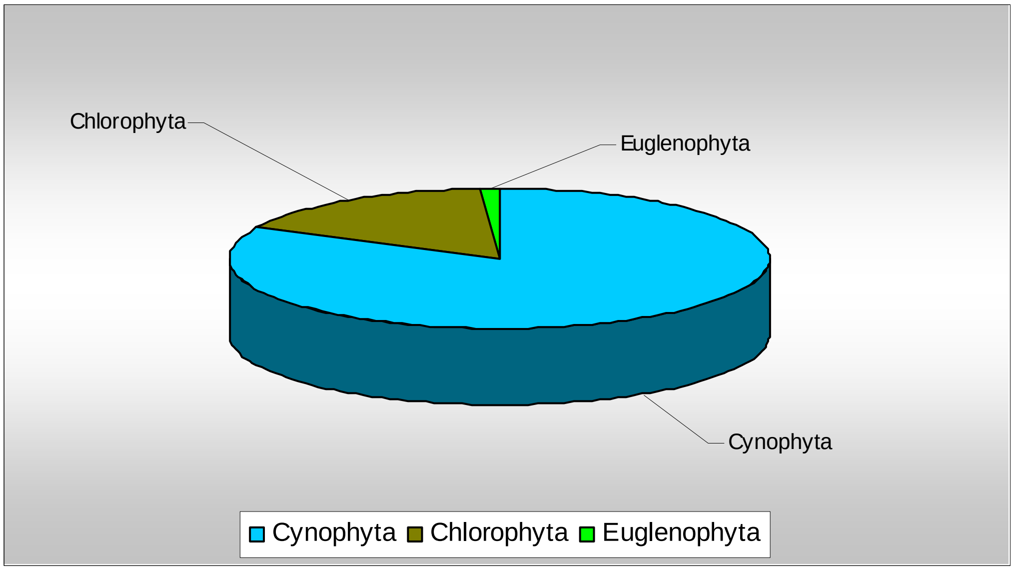


Figure 12: Relative Abundance of Zooplankton at Kinjhar Lake

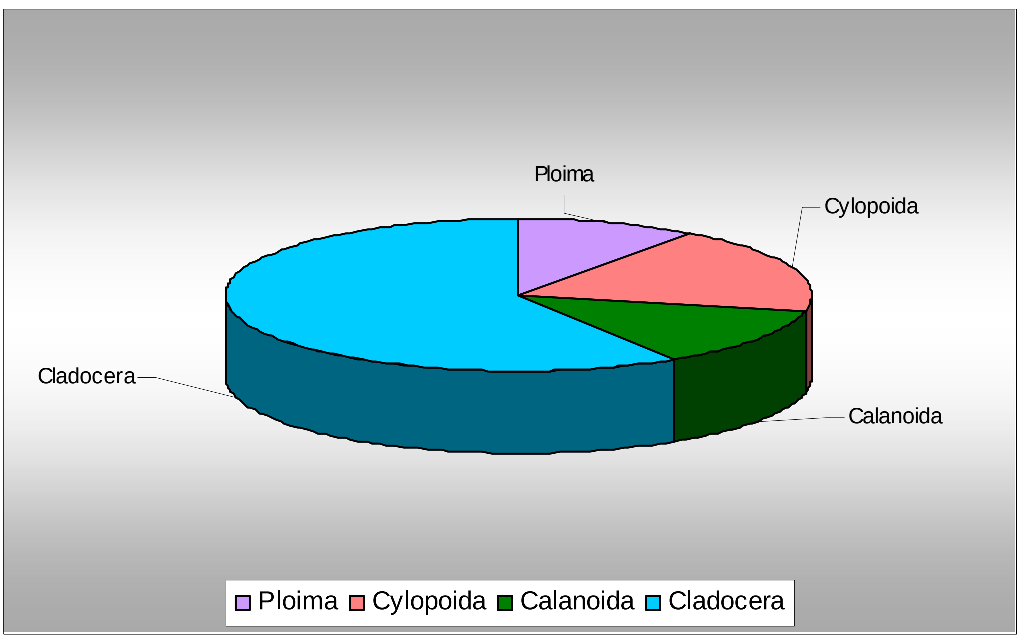
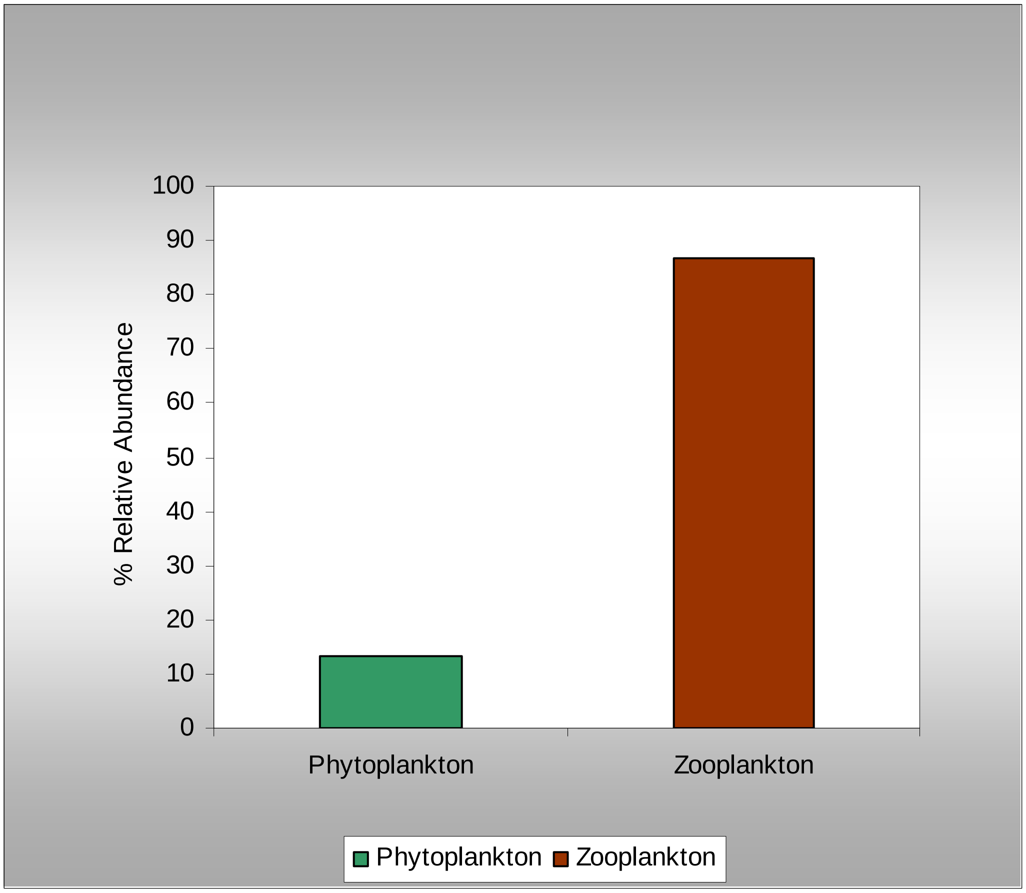


Figure 13: Relative Abundance of Planktons at Kinjhar Lake



3.3 - Chotiari Reservoir

3.3.1 Natural Vegetation Assessment

FINDINGS OF THE NATURAL VEGETATION SURVEY

3.3.1.1 Phytosociological Study of Chotiari Reservoir

Transect No: 1

Site: Harani Coordinates: 26^{o} 07' 38.0"N 69^{o} 00' 44.4" E

Soil Type: Sandy gravely Grazing Intensity: Moderate

Plant Community: *Fagonia indica* DMY: 149.9 kg/ha

This site is situated on outer side of embankment near Nara canal. Since this embankment is relatively newly constructed, therefore, different plant species are colonizing the area. Plant species recorded on this site included *Fagonia indica, Cressa cretica, Calotropis procera, and Prosopis juliflora*. A few plants of *Indigofera cordifolia, Zizyphus nummularia and Dactylocteneum aegypticum* were also seen in the vicinity of the transect point. *Solanum nigrum, Salsola imbricata* and *Convolvulus arvensis* were also observed.

Table 57: Phytosociological Parameters of T1 at Chotiari

Species	No	R.F. %	R.F. %	R.D %	I.V.	SDR
Calotropis procera	1	0.19	1.72	25.00	26.91	8.97
Senna italica	9	4.61	12.07	25.00	41.68	13.89
Fagonia indica	625	95.20	86.21	50.00	231.41	77.14

Transect No: 2

Site: Pir Bakhsh Behn Coordinates: 26^o 10’45.2”N 69^o 02’ 11.3” E

Soil Type: Sandy loam Grazing Intensity: Moderate

Plant Community: *Pluchea lanceolata* DMY: 66.4 Kg/ha

The site lies inside embankment on northern side where sand dunes and small wetlands are interspersed. Natural vegetation consists of *Aerva javanica, Crotalaria burhia, Corchorus tridens, Calotropis procera, Pluchea lanceolata, Desmostachya bipinnata, Cressa cretica, Limeum indicum, Sesuvium sesuvioides, Euphorbia clarkiana, Aristida adscensionis, Saccharum spontaneum, Blepharis scindica, Digera muricata, and Tribulus longipetalus.* Area is frequently visited by livestock as evident from grazing signs.

Table 58: Phytosociological Parameters of T2 at Chotiari

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Octhochloa compressa	7	12.95	6.98	8.33	28.26	9.42
Calotropis procera	1	0.51	2.33	8.33	11.17	3.72
Senna italica	2	4.62	2.33	8.33	15.27	5.09
Corchorus tridens	2	1.41	4.65	8.33	14.39	4.80
Crotalaria burhia	1	1.92	2.33	8.33	12.58	4.19
Desmostachya bipinnata	5	11.03	11.63	8.33	30.99	10.33
Euphorbia clerkiana	1	2.56	2.33	8.33	13.22	4.41
Farsetia hamiltonii	1	2.18	2.33	8.33	12.84	4.28
Indigofera cordifolia	1	1.54	2.33	8.33	12.20	4.07
Indigofera argentea	1	1.92	2.33	8.33	12.58	4.19
Limeum indicum	1	1.28	2.33	8.33	11.94	3.98
Pluchea lanceolata	31	58.08	58.14	8.33	124.55	41.52

Transect No: 3

Site: Sortham Coordinates: 26^o 12’ 18.5”N 69^o 03’ 54.0” E

Soil Type: Grazing Intensity: Over Grazing

Plant Community: *Dactyloctenum-Desmostachya* DMY: 126.7 Kg/ha

Most of the area is covered by sand dunes representing typical desert flora. In between dunes there are water bodies containing mostly *Typha* and *Phragmites sp*. Grazing and wood cutting pressure is intense. However, dense vegetation of trees, grasses and forbs exhibits rehabilitation potential. Natural vegetation consists of *Prosopis cineraria, Acacia jacquemontii, Salvadora persica, Salvadora oleoides, Tamarix dioica, Pluchea lanceolata, Cenchrus prieurii, Desmostachya bipinnata, Dactylocteneum aegyptium, Euphorbia clarkiana, Eragrostris ciliaris, Sesuvium sesuvioides, Trianthema triquetra, Senna italica, Corchorus tridens, Cenchrus biflorus, and Tribulus terrestris.*

Table 59: Phytosociological Parameters of T3 at Chotiari

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Octhochloa compressa	18	5.56	6.40	4.17	16.12	5.37
Senna italica	2	0.34	1.16	0.76	2.26	0.75
Corchorus tridens	17	3.12	5.81	3.79	12.72	4.24
Cyprus rotundus	1	0.18	0.58	0.38	1.14	0.38
Dactyloctenium aegyptium	84	16.10	23.26	56.06	95.42	31.81
Desmostachya bipinnata	68	31.47	24.42	15.91	71.80	23.93
Eragrostis barrelieri	10	1.44	5.23	5.68	12.35	4.12
Eragrostis minor	7	1.62	2.33	0.76	4.70	1.57
Euphorbia clarkeana	1	0.18	0.58	0.38	1.14	0.38
O.M.	1	1.22	0.58	0.38	2.18	0.73
Pluchea lanceolata	14	15.83	6.98	2.27	25.08	8.36
Salvadora oleoides	1	6.72	0.58	0.38	7.68	2.56
Sesuvium sesuvioides	21	5.65	6.40	4.17	16.21	5.40
Trianthema crystallina	1	0.12	0.58	0.38	1.08	0.36
Trianthema portulacastrum	29	8.68	11.63	0.38	20.68	6.89
Tribulus terrestris	6	1.77	3.49	4.17	9.43	3.14

Transect No: 4

Site: Kumbhari Basaat (Jalal)
Coordinates: 26° 07' 24.96"N 69° 05' 38.9" E
Soil Type:
Grazing Intensity: Over Grazing
Plant Community: *Calotropis procera*
DMY: 116.1 Kg/ha

The site is situated inside bund in a depression where the species are *Cordia myxa, Dalbergia sisso, Acacia nilotica, Prosopis cineraria, Physalis peruviana, Suaeda fruticosa, Salvadora oleoides, Saccharum bengalense, Zizyphus nummularia, Brachiaria ramose, Dactyloteneum sindicum, Datura alba, Aerva javanica, Mukia maderaspatana,* and

Convolvulus arvensis. Thick vegetation along water bank gives this site a lot of aesthetics.

Table 60: Phytosociological Parameters of T4 at Chotiari

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Acacia nilotica	5	17.30	13.89	21.28	52.47	17.49
Achyranthes aspera	1	0.30	2.78	4.26	7.33	2.44
Aerva javanica	5	1.70	13.89	2.13	17.71	5.90
Alhagi maurorum	6	3.76	11.11	21.28	36.15	12.05
Amaranthus graecizans	1	0.05	2.78	2.13	4.95	1.65
Calotropis procera	16	49.31	19.44	19.15	87.91	29.30
Convolvulus arvensis	1	2.52	2.78	2.13	7.43	2.48
Cordia myxa	1	5.04	2.78	2.13	9.95	3.32
Cynodon dactylon	1	0.16	2.78	2.13	5.07	1.69
Datura alba	1	0.92	2.78	2.13	5.82	1.94
Mukia maderaspatensis	2	4.35	5.56	4.26	14.16	4.72
Prosopis juliflora	4	2.47	8.33	8.51	19.32	6.44
Saccharum benghalense	3	9.17	2.78	2.13	14.07	4.69
Salvadora oleoides	1	0.69	2.78	2.13	5.59	1.86
Tribulus terrestris	1	1.83	2.78	2.13	6.74	2.25
Zygophyllum simplex	1	0.44	2.78	2.13	5.34	1.78

Transect: 5

Site: Kalach near Phuleli   Coordinates: 26° 06’ 26.3”N 69° 09’ 28.8” E

Soil Type: Sandy loam   Grazing Intensity: Over Grazing

Plant Community: *Dactyloctenum egypten*   DMY: 124 Kg/ha

The site is situated along side dirt road leading to Phuleli. A lot of herds of goats were grazing around and such severe grazing is apparent from the condition of natural vegetation which seemed under severe stress. Natural flora consists of *Prosopis cineraria, Calligonum polygonoides, Salvadora persica, Lycium edgeworthii, Indigofera argentea, Blepharis scindica, Pluchea lanceolatus, Eragrostis barrelieri, Capparis decidua, Zizyphus nummularia, Calotropis procera, Leptadenia* *pyrotechnica, Crotalaria burhia, Corchorus tridens, Ochthochloa compressa, Desmostachya bipinnata, Abutilon bidentatum, Salvadora oleoides, Cassia italica and, Indegofera linifolia.*

Table 61: Phytosociological Parameters of T5 at Chotiari

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Octhochloa compressa	14	5.01	5.88	0.54	11.44	3.81
Aerva javanica	1	4.85	1.18	0.54	6.57	2.19
Blepharis sindica	1	0.48	1.18	0.54	2.20	0.73
Brachiaria eruciformis	1	0.65	1.18	0.54	2.36	0.79
Calotropis procera	1	0.26	1.18	0.54	1.98	0.66
Senna italica	3	1.23	2.35	1.08	4.66	1.55
Cleome scaposa	2	1.62	2.35	1.08	5.05	1.68
Calligonum polygonoides	2	8.08	2.35	1.08	11.52	3.84
Corchorus tridens	9	1.36	10.59	14.44	26.39	8.80
Crotalaria burhia	1	2.91	1.18	0.54	4.63	1.54
Dactyloctenium aegyptium	45	7.53	12.94	48.20	68.67	22.89
Eragrostis barrelieri	3	0.65	1.18	1.62	3.45	1.15
Gisekia pharnaceoides	2	0.32	2.35	1.08	3.76	1.25
Indigofera argentea	19	7.31	12.94	3.25	23.50	7.83
Indigofera cordifolia	1	0.65	1.18	4.87	6.70	2.23
Indigofera hochstetteri	6	4.53	7.06	2.17	13.75	4.58
Limeum indicum	1	0.42	1.18	0.54	2.14	0.71
Lycium ruthenicum	5	2.85	5.88	2.71	11.44	3.81
Lycium edgeworthii	2	6.47	2.35	1.08	9.90	3.30
Pluchea lanceolata	7	12.45	7.06	4.33	23.84	7.95
Prosopis cineraria	3	18.11	2.35	1.08	21.54	7.18
Salvadora oleoides	1	4.85	1.18	0.54	6.57	2.19
Sesuvium sesuvioides	6	3.82	7.06	3.25	14.12	4.71
Tribulus terrestris	2	0.71	2.35	2.71	5.77	1.92
Tribulus indica	1	0.65	1.18	0.54	2.36	0.79
Tribulus longipetalas	2	2.26	2.35	1.08	5.70	1.90

Transect No: 6

Site: Noon Gharo Lake Coordinates: 26^{o} 05’ 04.7”N 69^{o} 12’ 07.7” E

Soil Type: Sandy Grazing Intensity: Over Grazing

Plant Community: *Indigofera argentea* DMY: 155.2 Kg/ha

The site is situated at the bank of Noon Gharo Lake on sand dunes near a village. This is a grazing ground of the livestock of neighbouring habitation. Trees are in stunted form due to increased grazing pressure. Natural vegetation consists of *Prosopis cineraria, Salvadora oleoides, Calotropis procera, Calligonum polygonoides, Aerva javanica,* *Salsola imbricata, Lycium edgeworthii, Limeum indicum, Indigofera argentea, Indigofera cordifolia, Octhochloa compressa, Tribulus terrestris, Dactyloctenium sindicus* and, *Corchorus tridens.*

Table 62: Phytosociological Parameters of T6 at Chotiari

Species	No	R.C. %	R.F.%	R.D %	I.V.	SDR
Octhochloa compressa	1	0.54	1.16	0.53	2.23	0.74
Boerhavia diandra	1	0.39	1.16	0.53	2.08	0.69
Cenchrus biflorus	6	1.08	2.33	3.17	6.58	2.19
Calligonum polygonoides	3	10.15	2.33	1.59	14.06	4.69
Crotalaria burhia	1	1.23	1.16	0.53	2.92	0.97
Indigofera argentea	137	66.01	51.16	77.78	194.95	64.98
Indigofera cordifolia	2	0.83	2.33	1.06	4.22	1.41
Limeum indicum	32	15.69	27.91	12.17	55.77	18.59
Tribulus terrestris	5	1.72	5.81	2.12	9.65	3.22
Tribulus longipetalus	5	2.35	4.65	0.53	7.53	2.51

Transect No: 7

Site: Lude Waro Dharo (Island) Coordinates: 26^{o} 08’ 02.5”N 69^{o} 08’ 31.6” E

Soil Type: Sandy loam Grazing Intensity: Moderate

Plant Community: *Desmostachya-Gyandropsis gynandra* DMY: 482.5 Kg/ha

The site is situated on an island. Right in between water, there are big sand dunes where buffaloes were also grazing. Natural vegetation was in healthy state and consisted of species like *Prosopis cineraria, Salvadora persica, Calotropis procera, Lyceum edgeworthii, Crotalaria burhia, Gynandropsis gynandra, Typha sp., Ipomoea aquatica, Cenchrus biflorus, Corchorus tridense, Indigofera linifolia, Sesuvium sesuvioides, Bacopa moneirii, Pluchia lanceolata, Capparis decidua, Limeum indicum*

and*, Calligonum polygonoides.* Surrounding submerged plants include *Phragmites karka, Bacopa monneirii, Typha spp., Phyla nodiflora, Physalis peruviana, Saccharum bengalense, Ipomoea aquatica, Cyperus rotundus, Persicaria glabra, Eclipta prostrata, Cynodon dactylon, Saccharum griffithii, Nymphaea sp.* and*, Lycium edgerworthi*.

Table 63: Phytosociological Parameters of T7 at Chotiari

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Octhochloa compressa	6	2.46	4.17	2.05	8.69	2.90
Calotropis procera	3	5.49	2.50	1.03	9.02	3.01
Corchorus trilocularis	1	0.07	0.83	0.34	1.25	0.42
Corchorus aestuans	6	1.36	4.17	1.71	7.24	2.41
Corchorus tridens	8	1.53	6.67	2.74	10.93	3.64
Cuscuta sp.	2	0.61	1.67	0.68	2.96	0.99
Dactyloctenium aegyptium	4	1.53	2.50	1.03	5.05	1.68
Dactyloctenium scindicum	19	1.29	4.17	6.51	11.96	3.99
Desmostachya bipinnata	196	44.43	33.33	42.12	119.88	39.96
Gynandropsis gynandra	56	26.71	16.67	32.19	75.57	25.19
Heliotropium crispum	1	0.35	0.83	0.34	1.53	0.51
Indigofera argentea	1	0.09	0.83	0.34	1.27	0.42
Lycium edgeworthii	1	0.07	0.83	0.34	1.25	0.42
Physalis peruviana	1	0.19	0.83	0.34	1.36	0.45
Prosopis cineraria	1	0.07	0.83	0.34	1.25	0.42
Salvadora oleoides	1	5.00	0.83	0.34	6.17	2.06
Cenchrus biflorus	7	0.96	3.33	1.37	5.67	1.89
Sesuvium sesuvioides	3	2.35	2.50	1.03	5.87	1.96
Tribulus	9	2.11	7.50	3.08	12.69	4.23
Tribulus longipetalus	2	0.49	1.67	0.68	2.84	0.95
Tribulus terrestris	13	2.84	3.33	1.37	7.54	2.51

Transect No: 8

Site: Pakhroi Coordinates: 26^{o} 10’ 16.4”N 69^{o} 07’ 50.2” E

Soil Type: Sandy Grazing Intensity: Over Grazing

DMY: 302.3 Kg/ha Plant Community: *Desmostachya-Dactyloctenum – Indigofera-Pluchia*

The site is situated on another island in between lake. Natural vegetation consists of *Prosopis cineraria, Salvadora persica, Desmostachya bipinnata (along water edge), Gynandropsis gynandra, Amaranthus graecizans, Panicum turgidum, , Salvadora oleoides, Ipomoea argentea, Aerva javanica, Lycium edgeworthii, Limeum indicum, Cochorus tridense, Aristida sp., Blepharis sindica, Boerhavia diffusa, Lycium edgerworthii, Crotalaria burhia, Dipterygium glaucum, Polygala erioptera, Indigofera cardifolia, Indigofera linofolia, Calligonum polygonoides, Indigofera sessiflora, Trianthema portulacastrum, Zaleya pentandra, Pluchea lanceolata, Cenchrus biflorus, Ephedra ciliate, Salsola imbricata and, Gisekia pharancoides*

Table 64: Phytosociological Parameters of T8 at Chotiari

Species	No	Relative Cover %	Composition	R.D %	I.V.	SDR
Octhochloa compressa	1	0.53	1.06	0.50	2.09	0.70
Blepharis sindica	1	0.70	1.06	0.50	2.26	0.75
Corchorus tridens	11	3.80	11.64	5.50	20.94	6.98
Dactyloctenium scindicum	16	7.04	12.70	22.00	41.74	13.91
Dactyloctenum aegyptium	4	3.70	4.23	2.00	9.93	3.31
Desmostachya bipinnata	36	16.72	10.05	17.00	43.77	14.59
Tribulus longipetalus	1	0.32	1.06	0.50	1.87	0.62
Gynandropsis gynandra	3	2.64	3.17	1.50	7.31	2.44
Indigofera argentea	19	8.03	9.52	23.00	40.55	13.52
Indigofera cordifolia	1	0.53	1.06	0.50	2.09	0.70
Indigofera linifolia	8	5.88	6.35	3.00	15.23	5.08
Limeum indicum	4	4.26	4.23	2.00	10.49	3.50
Panicum turgidum	3	2.68	3.17	1.50	7.35	2.45
Pluchea sp.	17	21.82	16.93	1.50	40.25	13.42
Pluchea lenceolata	5	6.41	2.12	5.50	14.02	4.67
Trianthema portulacastrum	2	2.99	2.12	1.00	6.11	2.04
Tribulus longipetalus	7	5.28	7.41	11.50	24.19	8.06
Zaleya pentandra	2	6.69	2.12	1.00	9.80	3.27

Transect No: 9

Site: Padhrio Coordinates: 26° 10' 48.1"N 69° 09' 33.7" E

Soil Type: Sandy Grazing Intensity: Light Grazing

Plant Community: *Dactyloctenum* DMY: 552.6 Kg/ha

The site is yet another island with healthy grass cover. Natural vegetation consisted of Mesquite *(Prosopis juliflora), Tamarix indica, Salvadora persica, Acacai jacquemontii, Euphorbia caducifolia, Prosopis cineraria, Salvadora oleoides, Corchorus tridens, Desmostachya bipinnata, Indigofera linifolia, Indigoferal sessiflora, Panicum turgidum, Gynandropsis gynandra, Tephrosia uniflora, Tephrosia purpurea, Ochthochloa compressa, Indigofera cardifolia, Pluchea lanceolata, Indigofera argentea, Sesuvium sesuvioides, Trianthema crystallina, Sporobolus arabicus, Zelyea pentendra, Amaranthus graecizens, Boerhavia procumbense, Gisekia pharanceoides, Dipterygium glaucum, Trianthema triquetra, Citrullus colocynthis, Cocculus hirsutus, Ephedra ciliata, Aristida adscensionis, Tribulus longepetalus* and, *Cyprus rotundus.*

Table 65: Phytosociological Parameters of T9 at Chotiari

Species	No	R.C. %	R.F. %	R.D %	I.V.	SDR
Octhochloa compressa	1	0.50	0.94	1.04	2.48	0.83
Brachiaria ramose	4	1.16	2.83	1.04	5.04	1.68
Corchorus tridens	25	5.15	16.04	2.08	23.28	7.76
Dactyloctenium aristatum	150	28.85	19.81	71.35	120.01	40.00
Dactyloctenium aegyptium	58	9.41	5.66	1.56	16.63	5.54
Desmostachya bipinnata	22	9.53	12.26	0.78	22.57	7.52
Euphorbia caducifolia	2	3.82	1.89	0.52	6.23	2.08
Gynandropsis gynandra	15	10.48	11.32	2.34	24.14	8.05
Indigofera cordifolia	3	1.33	2.83	0.78	4.94	1.65
Indigofera argentea	11	3.49	6.60	2.08	12.18	4.06
Lycium edgeworthii	1	3.66	0.94	0.26	4.86	1.62
Panicum turgidum	3	3.24	2.83	0.78	6.85	2.28
Pluchea	20	12.67	11.32	14.06	38.05	12.68
Pluchea linceolata	2	2.66	1.89	0.52	5.07	1.69
Salvadora oleoides	1	3.49	0.94	0.26	4.70	1.57
Cenchrus biflorus	1	0.05	0.94	0.26	1.25	0.42
Tribulus longipetalus	1	0.50	0.94	0.26	1.70	0.57

Transect No: 10

Site: Padhrio Coordinates: 26^o 11' 43.9"N 69^o 09' 24.5" E

Soil Type: Sandy Grazing Intensity: Moderate

Plant Community: *Indigofera sessiliflora-Dactyloctenium* DMY: 324.7 Kg/ha

It is a typical desert site with large sand dunes situated at the bank of lake. Padhrio village is also situated nearby. Large herds of cattle and goats were grazing all around. The site represented good growth of grasses and bushes probably due to recent rains. Natural vegetation consisted of *Euphorbia caudicipholia, Leptadenia pyrotechnica, Aerva jwanica, Acacia jacquomontii, Salvadora oleoides, Aristida adscensioinis, Aristida funiculata, Calotropis procera, Corchorus tridense, Eragrostis sp., Indigofera sessiliflora, Limium indicum, Panicum turgidum* and, *Tribulus longipetalas.*

Table 66: Phytosociological Parameters of T10 at Chotiari

Species	No	R.C %	Composition	R.D %	I.V.	SDR
Acacia jacquemontii	1	6.41	0.99	0.65	8.05	2.68
Octhochloa compressa	14	5.40	7.92	2.61	15.94	5.31
Aristida adscensionis	1	0.23	0.99	0.65	1.87	0.62
Aristida funiculate	1	0.57	0.99	0.65	2.22	0.74
Calotropis procera	1	0.69	0.99	0.65	2.33	0.78
Citrullus colocynthis	1	1.83	0.99	0.65	3.47	1.16
Cocculus hirsutus	1	0.23	0.99	4.58	5.79	1.93
Corchorus tridens	1	0.23	0.99	0.65	1.87	0.62
Dactyloctenium aegyptium	183	21.77	17.82	18.30	57.89	19.30
Eragrostis barrelieri	1	0.46	0.99	0.65	2.10	0.70
Euphorbia caducifolia	1	3.89	0.99	0.65	5.53	1.84
Heliotropium crispum	1	2.06	0.99	0.65	3.70	1.23
Indigofera argentea	24	11.70	12.87	18.95	43.52	14.51
Indigofera cordifolia	9	5.95	3.96	1.96	11.87	3.96
Indigofera linifolia	2	0.92	1.98	1.31	4.20	1.40
Indigofera sessiliflora	51	18.27	24.75	32.68	75.70	25.23
Leptadenia pyrotechnica	1	3.89	0.99	0.65	5.53	1.84
Lawsonia inermis	1	4.58	0.99	0.65	6.22	2.07
Limeum indicum	2	1.10	1.98	1.31	4.39	1.46
Limium indicum	1	0.57	0.99	0.65	2.22	0.74
Lycium ruthenicum	1	1.83	0.99	0.65	3.47	1.16
Panicum turgiden	2	1.03	1.98	1.31	4.32	1.44
Tephrosia strigosa	1	0.11	0.99	0.65	1.76	0.59
Tribulus terrestris	12	5.38	8.91	5.88	20.17	6.72
Tribulus longipetalus	3	0.92	2.97	1.96	5.85	1.95

Table 67: Summary of Plant Communities, Associated species and forage production in Chotiari Wetland Complex

Site #	Site	Coordinates	Plant Community	Vegetation type and dominant species	Soil Type	DMY (Kg/ha)	Grazing condition
T-1	Harani	26° 07' 38.0"N 69° 00' 44.4" E	*Fagonia indica*	*Fagonia indica, Cressa cretica, Calotropis procera, and Prosopis juliflora*. A few plants of *Indegofera cordifolia, Zizyphus nummularia and Dactylocteneum agyptium, Solanum nigrum, Salsola imbricata* and *Convolvulus arvensis*	Sandy gravely	149.9	Moderate
T-2	Pir Bakhsh Behn	26° 10'45.2"N 69° 02' 11.3" E	*Pluchea lanceolata*	*Calotropis* procera, *Aerva javanica, Crotolaria burhia, Corchorus tridens, Pluchea lanceolata, Desmostachya bipinnata,Senna italica, Limeum indicum, Sessuvium sesuvioides, Euphorbia clarkiana, Aristida adscensionis, Saccharum spontaneum, Blephrus scindicus, Digera muricata, and Tribulus logepetalus.*	Sandy, Loam	66.4	Over grazed
T-3	Sortham	26° 12' 18.5"N 69° 03' 54.0" E	*Dactyloctenum-Desmostachya*	*Prosopis cineraria*, *Acacia Jacquemontii, Salvadora persica, Salvadora oleoides, Tamarix dioica, Salvadora oleoides, Pluchia lanceolata, Salvadora oleoides, Cenchrus sp., Desmostachya, Dactyloctenium sindicum, Euphorbia clarkeana, Erogrostris sp, Trianthema triquetra, Senna italica, Corchorus tridens, Cenchrus sp., and Tribulus terrestris.*		**126.7**	Over Grazed
T-4	Kumbhari Basaat (Jalal)	26° 07' 24.96"N 69° 05' 38.9" E	*Calotropis procera*	*Cordia myxa, Dalbergia sissoo, Acacia nilotica, Prosopis cineraria, Physalis minima, Sueada sp., Salvadora oleoides, Saccharum bengalense, Zizyphus nummularia, Brachiaria ramosa, Dactylocteneum*	Clay loam	116.1	Over Grazing

Site #	Site	Coordinates	Plant Community	Vegetation type and dominant species	Soil Type	DMY (Kg/ha)	Grazing condition
				sindicum,Datura alba, Aerva jwanica, Mukia madraspatana, and Convolvulus sp.			
T5	Kalach near Phuleli	26^{o} 06' 26.3"N 69^{o} 09' 28.8" E	*Dactyloctenum egypten*	*Prosopis cineraria, Calligonum polygonoides, Salvadora persica, Lycium edgeworthi, Indigofera argentea, Blepharis scindicus, Pluchia lanceolatus, Eragrostris sp., Capparis deciduas, Zizyphus nummularia, Calotropis procera, Leptadenia pyrotechnica,*	Sandy loam	124. 0	Moderate
T6	Noon Gharo Lake	26^{o} 05' 04.7"N 69^{o} 12' 07.7" E	*Indigofera argentea*	*Prosopis cineraria, Salvadora oleoides, Calotropis procera, Calligonum polygonoides, Aerva javanica, Salsola foetida, Lycium, Indigofera argentea, Indigofera cordifolia, Ochthochloa compressa, Tribulus terrestris, Dactyloctenium sindicum, Corchorus tridens*	sandy	155.2	Over grazing
T7	Lude Waro Dharo (Island)	26^{o} 08' 02.5"N 69^{o} 08' 31.6" E	*Desmostachya-Gyandropsisgynandra*	*Prosopis cineraria, Salvadora persica, Calotropis procera, Lycium edgeworthii, Crotalaria burhia, Gynodropsis gynandra, Typha sp., Ipomoea sp., Cenchrus biflorus, Cochorus tridense, Salvinia sp. Indigofera sp., Sessivium sp., Bacopa monerii, Pluchea lanceolata, Capparis deciduas, Limeum indicum, Calligonum polygonoides,*	Sandy loam	482.5	Over Grazing
T8	Pakhroi	26^{o} 10' 16.4"N 69^{o} 07' 50.2" E	*Desmostachya-Dactyloctenum-I.argentenea-Pluchea*	*Prosopis cineraria, Salvadora persica, Desmostachya bipinnata, Gynandropsis gynandra, Amaranthus graecizans, Panicum turgidum, Cassia italicu, Salvadora oleoides, Ipomea argentea, Aerva javanica, Lycium edgeworthii, Limium indica, Cochorus tridense, Aristida sp., Blepharis sindica, Boerhavia diffusa, Crotolaria burhia, Dipterygium*	sandy	302.3	Over Grazed

Site #	Site	Coordinates	Plant Community	Vegetation type and dominant species	Soil Type	DMY (Kg/ha)	Grazing condition
				glaucum, Polygala erioptera, Indigofera cordifolia, Indigofera linifolia, Calligonum polygonoides, I. sessiflora, Trianthema portulacustrum, Zaleya pentandra, Pluchea lanceolata, Cenchrus biflorus, Ephedra ciliata, Salsola imbricate, Gisekia pharnaceoides			
T9	Padhrio	26^{o} 10' 48.1"N 69^{o} 09' 33.7" E	*Dactyloctenum*	*Prosopis juliflora, Tamarix indica, Salvadora persica, Acacia jacquemontii, Euphorbia cadicifolia, Prosopis. cineraria, Salvadora oleoides, Corchorus tridens, Desmostachya, Ipomoea. linifolia, I. sessiliflora, Panicum turgidum, Gynodropsis gynandra, Tephrosia uniflora, Tephrosia purpurea, Ochthochloa compressa, Indigofera cordifolia, Pluchea lanceolata, Indigofera argentea, Sesuvium sesuvioides, Trianthema sp. Portulaca sp. Sporobolus sp., Zeleya pentendra, Amaranthus graecizans, Boerhavia procumbens, Gisekia pharanceoides.*	Sandy	552.6	Moderate
T10	Padhrio		*Indigofera sessiliflora-Dactyloctenium*	*Euphorbia cadicipholia, Leptadenia pyrotechnica, Aerva javanica, Acacia jacquemontii, Salvadora oleoides, Aristida adscensioinis, Aristida funiculata, Calotropis procera, Corchorus tridens, Eragrostis sp., Indigofera sessiliflora, Limium indicum, Panicum turgiden and Tribulus longipetalus*	*Sandy*	*324.7*	*Moderate*

3.3.1. 2 Summary Chotiari Flora

Vegetation assessment of Chotiari Reservoir was carried out from 21st to 22nd September, 2006. Some 115 plant species belonging to 83 genera and 40 families are identified. Of them, 22 grasses (Poaceae family) have been identified. The major plant families which contributed in the formation of vegetation in the area in question are Poaceae (19.13%) followed by Papilionaceae (10.43%), Amaranthaceae (5.22%), Capparidaceae (5.22%), Solanaceae (5.22%), Aizoaceae (3.48%), Mimosaceae (3.48%) and Zygophyllaceae (3.48%). The alphabetical checklist of species along their family, vernacular names and life form/habit is provided (Table 67). The contribution of plant families in the vegetation of project area are also summarized in Table-68.

Figure 14: Contribution of Plant Families to overall Flora of Chotiari Reservoir

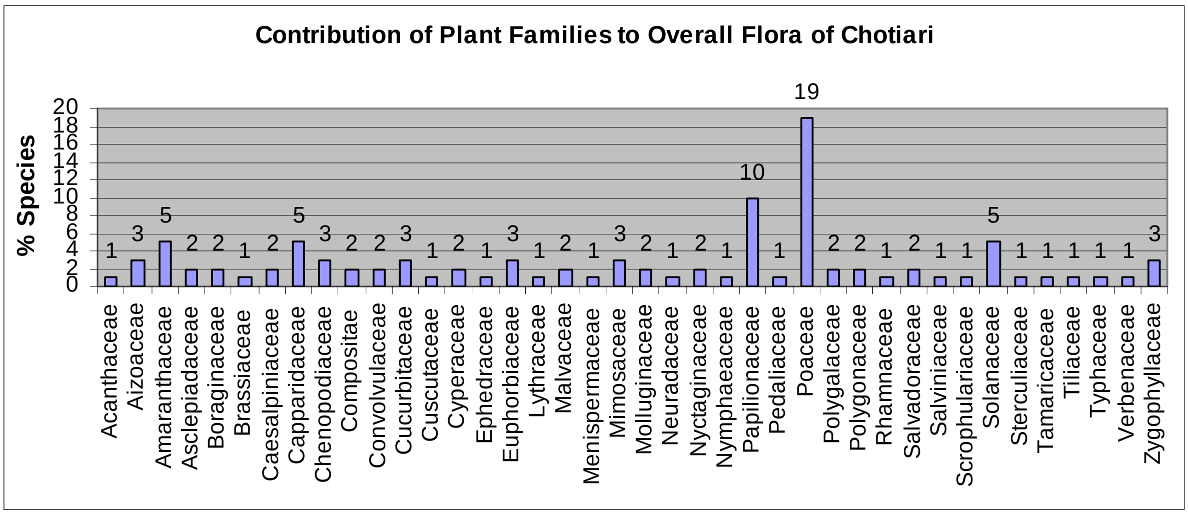


Table 68: List of plant species along with their families, vernacular names And life form of Chotiari Wetland Complex

	Family	Plant species	Life form	Habit
01	Acanthaceae	*Blepharis sindica* Stocks ex. T. Anders.	Therophyte	Shrub
02	Aizoaceae	*Sesuvium sesuvioides* (Fens) Verdi.	Therophyte	Herb
03	Aizoaceae	*Trianthema crystallina* (Forsk) Vahl	Therophyte	Herb
04	Aizoaceae	*Trianthema portulacastrum* L.	Therophyte	Herb
05	Aizoaceae	*Zaleya pentandra* (L.) Jeffrey.	Chamaephyte	Herb
06	Amaranthaceae	*Achyranthes aspera* L.	Phanerophyte	Robust herb
07	Amaranthaceae	*Aerva javanica* (Burm.f.)Juss.	Phanerophyte	Robust herb
08	Amaranthaceae	*Aerva sanguinolenta* (L.) Blume	Phanerophyte	Shrub
09	Amaranthaceae	*Alternanthera sessilis* (L.) DC.	Chamaephyte	Herb
10	Amaranthaceae	*Amaranthus graecizans* L.	Therophyte	Herb
11	Amaranthaceae	*Digera muricata* (L.) Mart.	Therophyte	Herb
12	Asclepiadaceae	*Calotropis procera* (Willd.) R. Br.	Phanerophyte	Shrub
13	Asclepiadaceae	*Leptadenia pyrotechnica* (Forsk.) Dcne.	Phanerophyte	Shrub
14	Asclepiadaceae	*Oxystelma esculentum* (L.f) R.Br.	Cryptophyte	Climber
15	Boraginaceae	*Cordia myxa* L.	Phanerophyte	Tree
16	Boraginaceae	*Heliotropium crispum* Desf.	Phanerophyte	Shrub
17	Brassicaceae	*Farsetia hamiltonii* Royle	Therophyte	Herb
18	Caesalpiniaceae	*Senna holosericea* (Fresen) Greuter	Phanerophyte	Shrub

19	Caesalpiniaceae	*Senna italica* Mill.	Phanerophyte	Shrub
20	Capparidaceae	*Capparis decidua* (Forsk.) Edgew.	Phanerophyte	Shrub
21	Capparidaceae	*Cleome brachycarpa* Vahl ex DC.	Chamaephyte	Herb
22	Capparidaceae	*Cleome scaposa* DC.	Therophyte	Herb
23	Capparidaceae	*Cleome viscosa* L.	Therophyte	Herb
24	Capparidaceae	*Dipterygium glaucum* Dcne.	Phanerophyte	Sub-shrub
25	Capparidaceae	*Gynandropsis gynandra* (L.) Briq.	Therophyte	Herb
26	Chenopodiaceae	*Haloxylon salicornicum* (Moq.) Bunge ex Boiss.	Phanerophyte	Shrub
27	Chenopodiaceae	*Salsola imbricata* Forsk.	Phanerophyte	Shrub
28	Chenopodiaceae	*Suaeda fruticosa* Forsk. ex J.F.Gmelin	Phanerophyte	Shrub
29	Compositae	*Eclipta prostrata* (L.) L.	Chamaephyte	Herb
30	Compositae	*Pluchea lanceolata* (DC.) C.B. Clarke	Phanerophyte	Shrub
31	Convolvulaceae	*Convolvulus arvensis* L.	Therophyte	Climber
32	Convolvulaceae	*Ipomoea aquatica* Forsk.	Hydrophyte	
33	Cucurbitaceae	*Citrullus colocynthis* (L.) Schrad.	Chamaephyte	Climber
34	Cucurbitaceae	*Luffa echinata* Roxb.	Phanerophyte	Climber
35	Cucurbitaceae	*Mukia maderaspatensis* (L.) M.J. Roem.	phanerophyte	Climber
36	Cuscutaceae	*Cuscuta sp*		Parasite
37	Cyperaceae	*Cyperus longus* L.	Hemicryptophyte	Sedge
38	Cyperaceae	*Cyperus rotundus* L.	Hemicryptophyte	Sedge
39	Ephedraceae	*Ephedra foliata* Boiss. & Ky. ex Boiss.	Gymnosperm	
40	Euphorbiaceae	*Euphorbia caducifolia* Haines	Phanerophyte	Shrub
41	Euphorbiaceae	*Euphorbia clarkeana* Hk.f.	Therophyte	Herb
42	Euphorbiaceae	*Euphorbia serpens* Kunth	Therophyte	Herb
43	Lythraceae	*Lawsonia inermis* L.	Phanerophyte	Shrub
44	Malvaceae	*Abutilon bidentatum* Hochst. ex A. Rich.	Phanerophyte	Shrub
45	Malvaceae	*Sida sp*	Phanerophyte	Shrub
46	Menispermaceae	*Cocculus hirsutus* (L.) Diels	Phanerophyte	Vine
47	Mimosaceae	*Acacia jacquemontii* Benth.	Phanerophyte	Tree
48	Mimosaceae	*Acacia nilotica* Delile	Phanerophyte	Tree
49	Mimosaceae	*Prosopis cineraria* (Linn.) Druce.	Phanerophyte	Tree
50	Mimosaceae	*Prosopis juliflora* (Swartz) DC.	Phanerophyte	Shrub
51	Molluginaceae	*Gisekia pharnaceoides* L.	Therophyte	Herb
52	Molluginaceae	*Limeum indicum* Stocks ex. T. And.	Therophyte	Herb
53	Neuradaceae	*Neurada procumbens* L.	Therophyte	Herb
54	Nyctaginaceae	*Boerhavia diandra* L.	Therophyte	Herb
55	Nyctaginaceae	*Boerhavia procumbens* Banks ex Roxb.	Cryptophyte	Herb
56	Nymphaeaceae	*Nymphaea sp*	Hydrophyte	Herb
57	Papilionaceae	*Alhagi maurorum* Medic.	Phanerophyte	Shrub
58	Papilionaceae	*Crotalaria burhia* Ham. Ex Bth.	Phanerophyte	Shrub
59	Papilionaceae	*Dalbergia sissoo* Roxb.	Phanerophyte	Tree
60	Papilionaceae	*Indigofera argentea* Burm.f.	Chamaephyte	Herb
61	Papilionaceae	*Indigofera cordifolia* Heyne ex Roth	Therophyte	Herb
62	Papilionaceae	*Indigofera hochstetteri* Baker	Therophyte	Herb
63	Papilionaceae	*Indigofera linifolia* (L.f.) Retz.	Therophyte	Herb
64	Papilionaceae	*Indigofera sessiliflora* DC.	Therophyte	Herb
65	Papilionaceae	*Tephrosia purpurea* (L.) Pers.	Chamaephyte	
66	Papilionaceae	*Tephrosia strigosa* (Dalz.) Sant.	Therophyte	Herb
67	Papilionaceae	*Tephrosia uniflora* Pers.	Phanerophyte	Shrub

68	Papilionaceae	*Tephrosia villosa* (L.) Pers.	Chamaephyte	
69	Pedaliaceae	*Sesamum indicum* L.	Theorphyte	Herb
70	Poaceae	*Aristida adscensioinis* L.	Therophyte	Grass
71	Poaceae	*Aristida funiculate* Trin. & Rupr.	Therophyte	Grass
72	Poaceae	*Aristida mutabilis* Trin. & Rupr.	Hemicryptophyte	Grass
73	Poaceae	*Brachiaria ovalis* (R. Br.) Stapf	Therophyte	Grass
74	Poaceae	*Brachiaria ramosa* (L.) Stapf	Therophyte	Grass
75	Poaceae	*Cenchrus biflorus* Roxb.	Therophyte	Grass
76	Poaceae	*Cenchrus prieurii* (Kunth) AMaire	Hemicryptophyte	Grass
77	Poaceae	*Cynodon dactylon* (L.) Pers.	Hemicryptophte	Grass
78	Poaceae	*Dactyloctenium aegyptium* (L.) P.Beauv.	Hemicryptophyte	Grass
79	Poaceae	*Dactyloctenium aristatum* Link	Therophyte	Grass
80	Poaceae	*Dactyloctenium scindicum* Boiss.	Therophyte	Grass
81	Poaceae	*Desmostachya bipinnata* (L.) Stapf	Therophyte	Grass
82	Poaceae	*Echinochloa colonum* (L.) Link	Therophyte	Grass
83	Poaceae	*Eragrostis barrelieri* Dav.	Therophyte	Grass
84	Poaceae	*Eragrostis ciliaris* (L.) R. Br.	Therophyte	Grass
85	Poaceae	*Octhochloa compressa* (Fork.) Hilu	Hemicryptophte	Grass
86	Poaceae	*Panicum turgidum* Forsk.	Hemicryptophyte	Grass
87	Poaceae	*Phragmites karka* (Retz.) Trin.	Hemicryptophyte	Tall grass
88	Poaceae	*Saccharum benghalense* Retz.	Hemicryptophyte	Tall grass
89	Poaceae	*Saccharum griffithii* Munro ex Boiss.	Hemicryptophyte	Tall grass
90	Poaceae	*Saccharum spontaneum* L.	Hemicryptophyte	Tall grass
91	Poaceae	*Sporobolus nervosus* Hochst.	Hemicryptophte	Grass
92	Polygalaceae	*Polygala erioptera* DC.	Therophyte	Herb
93	Polygalaceae	*Polygala irregularis* Boiss	Phanerophyte	Herb
94	Polygonaceae	*Calligonum polygonoides* L.	Phanerophyte	Shrub
95	Polygonaceae	*Persicaria glabra* (Willd.) Gome de la Maze	Chamaephyte	Herb
96	Rhamnaceae	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	Phanerophytes	Shrub
97	Salvadoraceae	*Salvadora oleoides* Dcne.	Phanerophyte	Tree
98	Salvadoraceae	*Salvadora parsica* L.	Phanerophyte	Tree
99	Salviniaceae	*Salvinia molesta* Mitchelle	Hydrophyte Fern	Herb
100	Scrophulariaceae	*Bacopa monnieri* (L.) Wettstein	Chaemophyte	Herb
101	Solanaceae	*Datura alba* Nees	Phanerophyte	Shrub
102	Solanaceae	*Lycium edgeworthii* Dunal	Phanerophyte	Shrub
103	Solanaceae	*Lycium ruthenicum* Murray	Phanerophyte	Shrub
104	Solanaceae	*Physalis divaricata* D. Don	Therophyte	Herb
105	Solanaceae	*Physalis peruviana* L.	Therophyte	Herb
106	Solanaceae	*Solanum nigrum* L.	Therophyte	Herb
107	Sterculiaceae	*Melhania denhamii* R. Br.	Chamaephyte	Under shrub
108	Tamaricaceae	*Tamarix dioica* Roxb.	Phanerophyte	Tree
109	Tiliaceae	*Corchorus tridens* L.	Therophyte	Herb
110	Typhaceae	*Typha sp*	Hemicryptophyte	Tall grass
111	Verbenaceae	*Phyla nodiflora* (L.) Greene	Chamaephyte	Herb
112	Zygophyllaceae	*Fagonia indica* Burm.f.	Chamaephyte	Herb/subshrub
113	Zygophyllaceae	*Tribulus longipetalus* Viv.	Therophyte	Herb
114	Zygophyllaceae	*Tribulus terrestris* L.	Therophyte	Herb
115	Zygophyllaceae	*Zygophyllum simplex* L.	Therophyte	Herb

Table 69: Dry Matter Forage and carrying Capacity of Chotiari Wetland Complex Sampling Sites

Transect No.	Kg/ha	Available Forage	A.U
1	149.9	89.94	12.85
2	66.4	39.84	5.69
3	126.7	76.02	10.86
4	116.1	69.66	9.95
5	124	74.4	10.63
6	155.2	93.12	13.31
7	482.5	289.5	41.36
8	302.3	181.38	25.9
9	552.6	331.56	47.37
10	324.7	194.82	27.83

3.3.1.3 *Two Ways Indicator Species Analysis (TWINSPAN)*

Cover data from transects of each of three sites (Keti Bundar, Kinjhar, Chotiari) were compiled using spreadsheet programme Microsoft® Excel®. These values ware then analyzed using software "*Two Ways Indicator Species Analysis (TWINSPAN*)" as mentioned earlier in Materials & Methods section. The results of the analysis for each of the three above-mentioned sites are described as under.

Chotiari Wetland Complex

Chotiari is represented by a variety of land forms. It is comprised of a number of tropical wetlands and desert region. This landscape was represented mainly by two plant communities, as discussed below.

- ***Indigofera argentea* - *Indigofera linifolia* - *Gynandropsis***

This community was found on Transects 1, 6, 8, 9 and 10. Transect 1 was situated on the side of main embankment where there was a lot of grazing and soil was deep. The community is represented by families Papilionaceae (*Indigofera argentea* - *Indigofera linifolia) and* Capparidaceae (*Gynandropsis gynandra).* Although there were a lot of other plant species present at these points, yet community was formed by these species.

❖ *Octhochloa – Pluchea - Salvadora*

This plant community was represented by Transects 2, 3, 5, 7 and 4. All these points were on sand dunes situated in vicinity of wetlands. The plant species comprising this community included *Octhochloa compressa* (family Poaceae) with a life form of Hemicryptophte, *Pluchea lanceolata (family* Compositae) and life form of Phanerophyte and *Salvadora oleoides* (family Salvadoraceae) and having life form of Phanerophyte.

Table 70: TWINSPAN Analysis – Chotiari

		Transect No.									
		1	6	8	9	10	2	3	5	7	4
	Plant Species										
47	*Boerhavia diandra*	-	1	-	-	-	-	-	-	-	-
49	*Indigofera argentea*	-	1	1	1	3	-	-	-	-	-
50	*Cocculus hirsutus*	-	1	2	-	1	-	-	-	-	-
51	*Cuscuta* reflexa	-	-	-	-	-	-	-	-	-	-
52	*Dactyloctenium aegyptium*	-	1	2	5	-	-	-	-	-	-
53	*Gynandropsis gynandra*	-	5	1	4	-	-	-	-	-	-
54	*Heliotropium crispum*	-	1	-	-	1	-	-	-	-	-
55	*Physalis divaricata*	-	1	-	-	-	-	-	-	-	-
57	*Panicum turgidum*	-	-	1	2	1	-	-	-	-	-
58	*Trianthema crystalline*	-	-	1	-	-	-	-	-	-	-
59	*Zaleya pentandra*	-	-	2	-	-	-	-	-	-	-
60	*Brachiaria ovalis*	-	-	-	1	-	-	-	-	-	-
61	*Euphorbia caducifolia*	-	-	-	2	2	-	-	-	-	-
62	*Pluchea lanceolata*	-	-	-	4	-	-	-	-	-	-
63	*Acacia jacquemontii*	-	-	-	-	3	-	-	-	-	-
64	*Aristida adscens*	-	-	-	-	1	-	-	-	-	-
65	*Aristida funiculate*	-	-	-	-	1	-	-	-	-	-
66	*Citrullus colocynthis*	-	-	-	-	1	-	-	-	-	-
67	*Indigofera cordifolia*	-	-	-	-	1	-	-	-	-	-
68	*Indigofera hochstetteri*	-	-	-	-	4	-	-	-	-	-
69	*Leptadenia pyrotechnica*	-	-	-	-	2	-	-	-	-	-
70	*Leptadenia pyrotechnica*	-	-	-	-	2	-	-	-	-	-
71	*Tephrosia purpurea*	-	-	-	-	1	-	-	-	-	-
10	*Indigofera linifolia*	-	5	2	2	4	1	-	2	1	-
11	*Limeum indicum*	-	3	2	-	1	1	-	1	-	-
43	*Limeum indicum*	-	-	2	-	1	-	-	1	-	-
56	*Tribulus longipetalus*	-	-	2	1	1	-	-	-	1	-
2	*Fagonia indica*	5	-	1	-	-	-	-	-	-	-
4	*Corchorus tridens*	-	-	-	3	1	1	2	-	1	-
14	*Dactyloctenium scindicum*	-	-	2	4	4	-	4	2	2	-
23	*Tribulus terrestris*	-	1	-	-	2	-	1	1	-	-
38	*Blepharis sindica*	-	-	1	-	-	-	-	1	-	-
44	*Lycium ruthenicum*	-	-	-	2	1	-	-	2	1	-

46	*Tribulus terrestris*	-	1	1	-	-	-	-	1	-	-
48	*Cenchrus prieurii*	-	1	-	1	-	-	-	-	1	-
3	*Octhochloa compressa*	-	1	-	1	2	2	2	2	2	-
5	*Crotalaria burhia*	-	1	-	-	-	1	-	1	-	-
6	*Desmostachya bipinnata*	-	-	3	4	-	1	5	-	5	-
12	*Pluchea lanceolata*	-	-	2	2	-	3	4	3	-	-
15	*Eragrostis barrelieri*	-	-	-	-	1	-	1	1	-	-
41	*Calligonum polygonoides*	-	2	-	-	-	-	-	3	-	-
7	*Euphorbia clarkeana*	-	-	-	-	-	1	-	-	-	-
8	*Farsetia hamiltonii*	-	-	-	-	-	1	-	-	-	-
9	*Indigofera cordifolia*	-	-	-	-	-	1	-	2	-	-
13	*Cyperus longus*	-	-	-	-	-	-	1	-	-	-
16	*Eragrostis barrelieri*	-		-	-	-	-	1	-	-	-
17	*Euphorbia serpens*	-	-	-	-	-	-	1	-	-	-
18	Organic Matter	-	-	-	-	-	-	1	-	-	-
20	*Sesuvium sesuvioides*	-	-	-	-	-	-	2	2	2	-
21	*Trianthema crystalline*	-	-	-	-	-	-	1	-	-	-
22	*Trianthema crystalline*	-	-	-	-	-	-	3	-	-	-
36	*Tribulus longipetalus*	-	-	-	-	-	-	-	-	2	-
39	*Brachiaria ovalis*	-	-	-	-	-	-	-	1	-	-
40	*Cleome scaposa*	-	-	-	-	-	-	-	1	-	-
42	Gise kia	-	-	-	-	-	-	-	1	-	-
45	*Prosopis cineraria*	-	-	-	-	-	-	-	4	1	-
1	Cass ia i	2	-	-	-	-	1	1	1	-	-
19	*Salvadora oleoides*	-	-	-	2	-	-	2	2	2	1
26	*Aerva javanica*	-	-	-	-	-	-	-	2	-	1
29	*Convolvulus arvensis*	-	-	-	-	-	-	-	1	-	2
24	*Acacia nilotica*	-	-	-	-	-	-	-	-	-	4
25	*Achyranthes aspera*	-	-	-	-	-	-	-	-	-	1
27	*Alhagi maurorum*	-	-	-	-	-	-	-	-	-	2
28	*Amaranthus graecizans*	-	-	-	-	-	-	-	-	-	1
30	*Cordia myxa*	-	-	-	-	-	-	-	-	-	2
31	*Cynodon dactylon*	-	-	-	-	-	-	-	-	-	1
32	*Datura alba*	-	-	-	-	-	-	-	-	-	1
33	*Mukia maderaspatensis*	-	-	-	-	-	-	-	-	-	2
34	*Prosopis juliflora*	-	-	-	-	-	-	-	-	-	2
35	*Saccharum benghalense*	-	-	-	-	-	-	-	-	-	3
37	*Zygophyllum simplex*	-	-	-	-	-	-	-	-	-	1
		0	0	0	0	0	0	0	0	0	1
		0	1	1	1	1	1	1	1	1	
			0	0	0	0	1	1	1	1	

3.3.1.5 Biodiversity Index & Species Richness:

I. **α-Diversity** (i.e., the species richness and species diversity within each locality). With reference to species richness, Kinjhar Lake surroundings have shown the highest α-diversity with a total of 41 plant families, 104 genera and 136 species, followed by Chotiari with 40 families, 82 genera, and 116 species, Pai forest with 27 families, 51 genera, and 64 species; and Keti Bunder with 19 families, 32 genera and 39 species.

Among various families, Gramineae exhibited the highest species richness in Kinjhar, Chotiari, and Pai; whereas in Keti Bunder Chenopodiaceae showed the highest diversity followed by Gramineae. This is indicative of the high salinity of the Keti Bunder area. Besides Chenopodiaceae, other halophytes/salt tolerant species include *Avicennia marina, Aeluropus lagopoides, Sporobolus virginicus* and three species of *Tamarix.*

II. **β-Diversity** (i.e., the species turnover from one locality to other locality or diversity between localities)

Localities were compared in pairs with every possible combination. The highest number of species was shared by Kinjhar and Chotiari, *i.e.*, these two localities had 57 species in common, followed by Chotiari – Pai with 30 species in common, Kinjhar-Pai with 30 species in common, Kinjhar-Keti with 27 species in common, and Keti-Chotiari with 13 species in common, and Keti-Pai with 12 species in common.

These locality pairs showed similarity index likewise.

Table 71: Similarity Index and β-diversity of study sites

Localities pairs	Similarity index (CC)	*β-diversity
1. Keti-Kinjhar	0.308	1.691
2. Keti-Chotiari	0.168	1.832
3. Keti-Pai	0.233	1.767
4. Kinjhar-Chotiari	0.452	1.548
5. Kinjhar-Pai	0.30	1.700
6. Chotiari-Pai	0.333	1.667

* Inversely proportional to similarity index.

Only 8 species were found to be shared by all localities, among which the notorious alien species *Prosopis juliflora* was most prominent.

III. **γ-Diversity** (i.e., diversity of all localities collectively).

The total number of species of all the four localities came to be 241. However, this number is liable to increase in future with more detailed surveys in different parts of the year.

3.3.1.6 Significant findings:

Luffa echinata: According to Flora of Pakistan records, it was considered a rare species recorded only from Chitral, Swat and Tharparkar. However, we have found it to be abundantly present both in Kinjhar (particularly in the part of lake towards Chillia bund) and Chotiari reservoir on small islands.

3.3.2 Large Mammals Assessment

FINDINGS OF MAMMALIAN FAUNA:

3.3.2.1 Situation Analysis:

The large mammalian species are suffering severely from habitat degradation, persistent hunting pressure and developmental activities. The wild population of species like Hog deer has become almost extinct.

The species of large mammals recorded from Chotiari area is given in Table 72.

Table 72: List of Large Mammals recorded at Chotiari

S.#	Order	Family	Scientific Name	English Name	Urdu Name	Sindhi Name
1	Carnivora	Canidae	*Canis aureus*	Asiatic Jackal	Geedar	Giddarr
2			*Vulpes vulpes*	Desert Fox	Sahrai Lomri	
3		Mustelidae	*Lutra perspicillata*	Smooth Indian Otter	Udh Bilao	Ludher, Ludra, Udni, Ludhro
4		Herpestidae	*Herpestes edwardsi*	Common Mongoose	Neola	
5		Felidae	*Felis chaus*	Jungle Cat	Jangli Billi	Jhangrarr Billo, Ban Bilar
6			*Felis libyca*	Desert Cat	Sehrai Billi	Rinn Billo, Jhang Meuo
7			*Felis viverrina*	Fishing Cat		Mash Billi, Mach Bagral
8	Artiodactyla	Bovidae	Sus scrofa	Wild Boar	Jangli Suar	Suar
9			*Gazella gazella*	Chinkara	Ghazala	Gora Hiran, Chitka Hiran, Ast
10		Cervidae	*Axis porcinus*	Hog Deer	Para	Pharra

Besides the above mentioned large mammals, observations on the following small mammal were also made.

ORDER: RODENTIA
FAMILY: MYSTRICIDAE

- Indian Porcupine *(Hystrix indica)*

3.3.2.2 Summary of Individual Species:

A summary of the individual species of large and medium sized mammals recorded in Chotiari area is given below:

1. ASIATIC JACKAL *(Canis aureus)*

It is widely distributed in the area and its call (hallowing) were heard from all the areas where surveys at night time was conducted. The animal is nocturnal and is active only at night. They live in almost all existing habitats available in Chotiari. Three animals were sighted, one adjacent to RD 26, one near RD 106 and one near Makhi Weir. The density of animals can not be worked out on this very preliminary finding and requires extensive survey but it is estimated that it has a fair density in the area.

Source: http://images.google.com

Change in land use practices, reduction in wilderness areas and development works, increasing human disturbances are the causes that is affecting their population. Though jackal population is adapting to these changes yet their population may eventually further decline in future.

2. DESERT FOX *(Vulpes vulpes)*

No direct or indirect observation of this animal could be made. However, the locals believe that it occurs in the Achro Thar, the desert area in the north eastern side of Chotiari where survey could not be conducted. However, it is rarely seen now as it has been persecuted in the past for its fur. The animal is protected but it is illegally caught. EIA Report (1993) also indicates its occurrence in the area.

Source: http://images.google.com

3. SMOOTH COATED OTTER *(Lutra perspicillata)*

No indirect or direct signs of occurrence of otters were observed during the present survey. However, the fishers and other people living in the area established that the otters are occasionally observed near thickets along Nara canal in the vicinity.

1. COMMON MONGOOSE *(Herpestes edwardsi)*

Source: http://images.google.com

It is widespread in the area mainly near water. It has no hunting pressure yet the snake charmers or jogis catch it. They carry mongoose for the snake – mongoose fight which is the source of their livelihood.

5. JUNGLE CAT *(Felis chaus)*

Source: http://images.google.com

The Jungle Cat is a small animal. They live in swampy grounds and reed beds and dense vegetation covers. They frequent the agricultural crops as well in Chotiari area. The main threat to this animal is killing by man because of their predation on poultry. The jungle cat is not strictly €nocturnal. Its fur was being exported to foreign countries in 1970s but now the government has imposed ban on export of wild animals and its derivates. It is also listed in Appendix II of CITES. The species is protected in Pakistan under Wildlife Act. The species is listed as 'Least Concern (LC)' in IUCN Red Data list.

EIA report (1993) reported its occurrence in Jamrao Head, Chandanwah and bank of Nara. In this brief survey, in about 5% of the sampled area, two jungle cats were observed in the area opposite Ranto Escape (RD 66) and RD 116, besides scats were observed. Density in available habitat would not exceed 2 cats/sq.km.

6. DESERT CAT (*Felis libyca)*

The desert cat is found in semi or scrub desert. The sign of its occurrence (scats) have been observed in Padrio area, in about 2% of the sampled area. At night they come closer to the human settlements. Personal communication with local people revealed that the cat is killed by the people as they attack the domestic poultry. The species is protected in Sindh under Sindh Wildlife Protection Ordinance 1972.

Source: http://images.google.com

7. FISHING CAT *(Felis viverrina)*

Fishing cat is found preferably in those areas of Chotiari where there is substantial thick cover near open water. They mainly feed upon fish and catch fish from the water pools. They also steal chicken from the villages in the locality hence people shoot or kill it whenever possible. One animal was sighted near IPD Bridge (RD 98) on Lower Nara canal embankment, gazing from the bank at about 8:00 o'clock. Evidences of its occurrence in 10% of the sampled area were noted. The animal is vulnerable and listed in Appendix II of CITES.

Source: http://images.google.com

8. WILD BOAR *(Sus scrofa)*

The Wild boar is a bulky animal with a thick neck and short legs and dark grey skin covered with long coarse black and brown bristles. In Chotiari, they inhabit the marshes covered with thick vegetation/reeds. It is gregarious living in groups. Wild boars are n€octurnal and are sighted at night foraging from dusk until dawn. They eat almost everything they come across including berries, carrion, roots, refuse, insects etc. They rampage the agricultural fields and thus people shoot/kill them. Although direct sighting of animal was not made in spite of undertaking night surveys, however evidences of its occurrence like destruction in agriculture fields caused by this animal were observed. They are common at this site, as evidence of its occurrence in 25% of the sample area was found. It is untouchable in Islam and hence the locals dislike this animal. It is persecuted by locals due to its destructive character for agriculture and religious hatred.

9. CHINKARA/INDIAN GAZELLE (*Gazella gazella)*

They prefer living in sandy deserts. They feed on desert grasses and mostly at night. They were reported to be common in the Thar Desert along the north eastern edges of Chotiari. They have been persecuted extensively. We did not survey in the desert area but according to local people, about 10 – 12 animals exist there. About 20 animals exist in Karam Dad Junejo's Private hunt.

Source: http://images.google.com

10. HOG DEER *(Axis porcinus)*

Hog Deer has a stocky appearance with shorter legs and muscular habit. They prefer to live in the area with extensive cover and near to rivers and marshlands. They inhabit in dense reed or thick riverside vegetation. It does not like areas of thick wood land and forest. They spend most of their time hidden in thick vegetation and only come out at night for feeding.

Chotiari reservoir possesses the habitat for Hog deer. EIA Report (1993) indicates the existence of two herds of Hog Deer within the reservoir area. One herd comprising of 30 – 40 animals was located in about 500 acres of dense *Saccharum* grass near Chandanwah. The other small herd was located in riverine forest further to the east, adjacent to the Thar Desert. The study also pointed out that both the population have hunting pressure.

EMMP of LBOD Stage 1 Project (1998) indicates the presence of 90 Hog deer in Chotiari Reservoir area. The report points out that the semi marsh reed bed, developed on low ground partially underwater and this habitat contains thick growth of Typha and Phragmites. On higher grounds the reed bed transform into open wood land and this is being the habitat of Hog deer in Chotiari reservoir area.

Azam (2002) indicates that population of Hog deer in Chotiari reservoir was mainly concentrated in reed vegetation and scrub forest on both sides of Ajo canal (Chandan wah). In the south, animals are found up to Goth Hassan Hingoro; in the east the animal are restricted to the west of Suiri Bhit. In the north, these were found between Chandanwah and Mir Khan Manguana. The population of the animal was extended up to the south west of Goth Piru Bahin. He estimated a population of 80 – 90 Hog deer in this area. Furthermore, he estimated a population of 50 -55 animals in privately owned Pir

Pagara reserve, located in riverine forest along Nara canal between RD 83 and RD 98. He further reported the occurrence of 6 – 7 animals in Awadhki forest.

During the present survey, Hog deer could not be found within the Reservoir area. However, about 50 animals exist in the private Game Reserve of Pir Pagara. Pir Pagara Reserve is situated in Deh Akanwari, along left bank of Nara canal. It is located between RD 83 and Rd 98 having an area of about 500 acre. The habitat consists of 186 *Typha* and other plant species include *Dalbergia sisso, Ziziphus sp, Populus euphratica.* The species is 'Protected' under Sindh Wildlife Protection Ordinance 1972.

11. INDIAN PORCUPINE *(Hystrix indica)*

The Porcupine comes under the category of small mammals hence particular observation on this animal was not made. However, its occurrence was observed and 3 animals were sighted. Its footprints and quills were found in 40% of the sampled area. The animal seems to be common.

3.3.2.3 Reporting of the Occurrence of Wild or Feral Ass

Prof. Amar Leghari of Sanghar (Pers. Comm.) narrated a story regarding occurrence of Wild Asses in Achro Thar. He stated that he along with some of his colleagues was collecting information on the effect of drought on Chinkara *(Gazella gazella)* in Achro Thar in May 2005, when they came across the presence of Wild Asses there. The distribution of Wild Ass has previously been reported from Thar along Pak – India border.

Some one among the big game hunters then informed him that the Chinkara were dying of thirst and fodder in their continuous search for the new pastures along the borderline. The scarcity of water and desert vegetation was threatening other species too, especially the wild Asses of Achro Thar which had always been in the face of twin disaster – i.e., the drought and the poaching. They visited the breeding ground of these Asses dominated with their favourite browse S*alvadora persica* and S*alvadora oleoides*, which were confined in by the huge sand hills. Two herds were sighted. They were too hostile to let us approach to them. With a strange shrieking bray the stallion warned them of the intruders, and then in a moment, they disappeared in the desert shrubs.

The innocent villagers told them that some influential persons are enemy of this animal. These hunters belonging to Lutko Mori had set up a mini market at their village where the Asses, caught from Thar, were sold in cheap rates.

According to Prof, Leghari these Asses were tamed by the shepherds of desert who then were arrested or killed by the then British Government during Hur Movement. The cattle as well as the horses and Asses, went wild as the regime struck hard upon them. The police and the army collected the cattle and horses but left the Asses as these had no value for them. These Asses did breed in utmost freedom and become the part of the wild life of Thar.

After independence, when the residents came back to their home areas, they found that their Asses had gone astray and that they were no longer a domestic animal. So they

decided not to disturb the increasing folds of these Asses. Since then they grew up in flocks, became more wild and varied. This 61(1941-2003) years long period has brought a new breed, which rarely had experienced man's presence in their surrounding.
It is about four or five years back that the Asses were accepted as the beast of burden in this district. They surprisingly replaced the bull-carts because of being sustainable and easy to manage. When it became the need of the farmers, who used to carry out their vegetables etc, in the market, the price per head rose to thousands, and they were even seen in the *Ma'al Pir'ris* waiting to be sold.

It is where the hunters converted them into a profit trade. They, in spite of rearing them up, began to trap and catch them from Thar and sell into the market.

A couple of months ago a truck of these Asses was brought at Lutko Mori some 20 kilometers from Sanghar and all were sold among the farmers. This practice is gaining ground among other groups too. They, according to the local sources, are making arrangements for such expeditions.

The recent information says that the resistance among the local communities is slowly building up, due to which some quarrels of minor nature are reported to have been taking place. To avoid any bitter consequences, the poachers have changed their strategy now. They, instead of charging them down upon in daytime, make ditches on the desert tracks and camouflage them by the foliage of desert scrubs. A camel is used to drive the Asses pass through the trap. And then they are taken to the distant markets – such as Rahimyar Khan and Bahawalpur etc.

The trappers catch both the sexes without sparing female ones. This will ultimately lessen the Asses' breed and put a stop to the wild life.

The people of the area and the animal lovers often show a strong concern over the indiscriminate hunt/trapping of these Asses. He suggested that the authorities should take notice for its protection. During the present survey, Achro Thar area was not visited hence confirmation of its occurrence could not be made.

3.3.3 Small Mammals Survey

FINDINGS OF THE SMALL MAMMALS STUDY

3.3.3.1 HABITAT DESCRIPTION

Small mammals form an indispensable component of the fauna of any area. They play an important role in determining the holding capacity and maintaining the number of animals in the higher trophic level of the food chain. The small mammals constituting rodents, insectivores, bats, mongooses, and the hedgehogs not only maintain ecological balance in a an ecosystem but also play a specific role in biological control necessary for a self sustained ecosystem. These small animals fill small 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 up by large animals like foxes, Jackals, cats, owls, eagles, kites, falcons, volves etc. living in the particular ecosystem. Unless better data on the small mammals are available, it is not possible to determine the status of the large animals.

MICROHABITATS OF THE AREA:

1. **Unstable sand dunes.** This habitat prevails in the eastern side of the Chotiari reservoir. As the name indicates, this habitat is highly unstable and keeps on changing with the direction of winds blowing in the desert. These sand dunes are devoid of any vegetation and inhabit hardly any burrowing animal due to instability of its strata.
2. **Stable sand dunes:** The stable sand dunes are the most important area in the desert from food chain point of view. These occupy three rodent species viz., *Gerbellus nanus*, *Meriones hurrianae* and the *Tatera indica*. The *Gerbellus nanus* is, however, the dominant species of this habitat.
3. **Interdunal flat lands:** There are several interdunal flat lands that are rich in clay contents and hard in texture. The main rodent species of this habitat are: *Gerbellus nanus*, *Meriones hurrianae*, *Tatera indica* and *Funambulus pennantii* but *Tatera indica* is the dominant species of this habitat.
4. **Agriculture-Desert interface:** This is also one of the most important microhabitat in this area. The area is occupied by *Gerbellus nanus*, *Meriones hurrianae*, *Tatera indica* and *Funambulus pennantii, Bandicota benghalensis* and the hedgehog, *Hemiechinus collaris.*
5. **Freshwater marshes:** This habitat is scattered all along the Nara canal and is regularly inundated. This area is specific for *viz.*, *Gerbellus nanus* and *Meriones hurrianae, Suncus murinus* species of rodents. Thick vegetation around these habitats may inhabit some other small mammal species.
6. **Canal irrigated agricultural areas:** These areas provide safe refuge to variety of animal species. A significant portion of the study area where water is available has been converted into agriculture fields over the years. The species, which have association with man or cannot tolerate scorching heat of the desert, are found there. Main species expected in these areas are *Mus musculus*, *Tatera indica, Rattus rattus*, *Funambulus pennantii, suncus murinus* and *Bandicota benghalensis*.

7- **Woody areas along the Chotiari Embankment:** Along the embankments are the thick vegetation dominated by *Prosopis juliflora*, bushes and fallen logs. This area provides various microhabitats for the small species including the meso-mammals.

8- **Human settlements:** There are numerous human settlements in the study area which are intensified in the canal irrigated area or agriculture-desert interface areas. Many small mammal species viz., *Rattus rattus*, *Funambulus pennantii, Mus musculus* are associated with human settlements.

3.3.3.2 Biological Information of the Key Species:

1. *Tatera indica* (Indian Gerbil)

Biology:

It is the most abundant rodent in the drier areas of Pakistan. It is also the most abundant species in the Chotiari reservoir area. It is a burrowing rodent and has occupied all the flat areas with deep soil in the agricultural fields, along the reservoir banks and in the desert. It is commonly found in the alluvial banks of the agricultural fields and lives in big colonies. It is the most aggressive animal knocking out the other sympatric species like *Gerbillus nanus*. It also has a close association with the *Meriones* species in the desert part of the area.

Behaviour:

It lives in the open areas in shallow burrows with wide holes made usually on the banks of the agricultural fields. During winter season they mainly occupy open areas and shift to close-by shady areas and bushes during the summer season. The species, G*erbillus nanus* which is sympatric to this species, is knocked out from the open areas to the bushes during the winter season but in the open areas during the summer season.

Habitat requirements:

Alluvial and deep soil usually surrounded by patches of bushes.

Breeding season:

This is highly prolific species and breeds through out the year in the hot environment of the area. There is, however, a bi-modal peak of breeding activity during the spring and monsoon season. Litter size varies from 1-9 with an average of five.

Feed requirements:

It is an omnivorous species eating insects, beetles, grains and leaves of trees but the seeds of crops dominate in their diet.

Distribution in Study Area

The species *Tatera indica* is one of the most common species in the Chotiari area. As it is the burrowing rodent so it is represented in compact alluvial deep soils and agriculture-desert interface areas, stable sand dunes and Woody areas with hard soils where burrowing is possible.

Distribution in Pakistan:
It is found in plain areas of Sindh and Punjab and Chagai, Kharan, Panjgur and Makran areas of Balochistan.

Distribution in the World:
It is found in drier regions of India and Sri Lanka. On the western side of Pakistan, it is found in Afghanistan, Iran, Iraq and Syria.

Abundance:
It is one of the most abundant species in the Nara desert.

Significance of the Species:
It is one of the most abundant species in the area. Being a big sized species, it plays an important role in the food chain of any ecosystem. It serves as a food item for mongooses, foxes, cats, rat snakes and cobras.

Status:
Population of this species is quite high in the flat areas and inter-dunal compact areas of desert. It is the most ecologically adaptable species and can intrude in other neighboring areas.

Threats/ Impact assessment:
No threat can be envisaged to this species in the study area.

2- *Gerbellus nanus* (Pygmy Gerbil)

Biology:
This is a small sized and agile gerbil hopping from place to place at night. It is more flexible in selecting its habitats than other sympatric species. Its niche is quiet wide and it is more tolerant species. It lives in burrows in open areas, thorny bushes, shady places and roots of many trees.

Behaviour:
This is not very colonial species. Their burrows are very simple consisting of a single underground chamber. They are strictly nocturnal and cover quite extensive territory when they come out of their burrows at night.

Habitat requirements:
This species is more flexible in selecting its habitat. It is sympatric with burrowing species, *Tatera indica* and *Meriones hurrianae* but sometimes is found independently in quiet firm and hard substratum with thick vegetation.

Breeding season:
Gestation period of this species is believed to be about twenty days. The litter size is two to three and young ones are born naked, blind and very feeble. Their eyes open in the second week. Breeding of this species probably continues throughout the year especially in the hot areas, however, peak breeding activities occur in two seasons, in summer and winter.

Feed requirements:
They mainly live on seeds of different plants. They supplement their diet with leaves of desert plants. During summer season they mainly feed on a variety of insects. They also feed on soft leaves of plants.

Distribution in Study Area:
The species *Gerbelus nanus* prefers the bushy and tree areas. It has an association with *Calligonum* bushes and makes intensive network of burrows all around this bush in the desert and desert-agriculture interface areas. It makes larger burrows as compared to the size of the rodent.

Distribution in Pakistan:
In Pakistan it is found in Punjab and Sindh. It is quiet common in the areas west of Indus at low altitudes. It is also common in Panjgur, Turbat and Nushki, Mekran and lower valleys of Balochistan. In N.W.F.P., it is only found in arid areas of Dera Ismail Khan District.

Distribution in the World:
Outside Pakistan, it is found in Afghanistan, Iran, Arabian and African countries. On the eastern side of the country, it is found in Rajistan and Gujrat states of India.

Abundance:
It is most abundant species of the desert in the Phulel areas and other desert-agriculture interface areas. It is also common in other parts of the country especially in the dry and arid zones of Punjab, Sindh and Balochistan.

Significance of the Species:
This species forms a significant component of the small mammals of the area. In the food chain, this species is preyed upon by owls and small carnivores. It is also eaten by eagle owl and long eared owl. Due to its small size, it is swallowed by many snake species. Many snakes enter their burrows and engulf the whole specimen

Status:
This is the most common species found in the desert-agriculture interface area.

3- *Meriones hurrianae* (Indian desert Jird)

Biology:
This Jird is famous for having very small ears. Its fur is very short and rough. The ventral fur instead of white as in other species of *Meriones* in Pakistan has a creamy colour. The soles of the hind feet are hairy and the claws tend to be dark brown or blackish.

Behavior:
This Jird is diurnal in feeding activity being more active in the early morning and late afternoon. During winter, they are active until the sun is warmer and then remain active throughout the day.

Habitat requirements:
It is found throughout the alluvial plains making burrows preferably on the banks of the cultivated fields and waste areas. It does not occur in rocky areas and needs a deep and firm soil for burrowing.

Breeding season:
It breeds throughout the year but there are two peak periods when litter size is large and maximum females are pregnant. These are during February, March and then again in July and August. The mean litter size for this species is around four.

Feed requirements:
It mainly feeds upon leaves, flowers, stems, grass roots, fallen seeds and insects.

Distribution in Study Area:
It is fairly common in the agriculture-desert interface areas, cultivated areas, inter-dunal flat areas and woody areas with alluvial soil.

Distribution in Pakistan:
It is one of the most abundant rodents in the tropical thorn scrub and uncultivated land throughout the Indus plain and southern and eastern areas of Balochistan.

Distribution World over:
Out side Pakistan, it is found in India, Afghanistan and Iran.

Abundance:
It is one of the three most common species of the Chotiari reservoir area and inhabits the interdunal and the compact areas in the waste and uncultivated lands.

Significance of the Species:
Being so widespread and abundant, it is an important source of food for all the common carnivores. The desert fox and Jungle cat hunt for this species. It is favorite food for rat snakes.

4- *Bandicota bengalensis* (Indian Mole rat)

Biology:

It is a medium sized rat with semi-naked scaly tail slightly shorter than head and body length. The body fur is hard and coarse and the belly dark Grey. There are four digits on the fore-feet and five digits on the hind feet each bearing a strong claw. The incisors are very broad and smooth on the interior surface without any longitudinal grooves.

Behavior:

The rodent is an active and powerful digger and excavates extensive burrow systems. It is mostly nocturnal and does not tolerate other animal in the same burrow. It stores food grains underground and breeds very rapidly. It is considered a serious agricultural pest. They are not gregarious and are extremely aggressive rodents.

Habitat requirements:

It needs mesic conditions with damp soil for burrowing and prefers embankments around cultivated fields. It avoids sand dune areas or dry rocky regions.

Breeding season:

The bandicoot breeds throughout the year and females bear large litters. Largest litters ar€e recorded from September to November when 14-18 young per litter were common. During rest of the year, 5-10 young are produced. It is found that sixty nine young per year are produced by a single female.

Feed requirements:

The principal food of this rodent is rice, succulent shoots of the rice plants, tubers of the grass, seeds of sorghum and millet.

Distribution:

It is found in Sindh, northern and eastern Punjab, parts of Hazara division, Abbotabad, and Peshawar. Outside Pakistan, it is found in India, Sri Lanka, Nepal, Burma, Malaysia and Indonesia.

Abundance:

It is very common species in the cultivated areas and the inter-face areas of the Chotiari reservoir.

Significance of the Species:

It is the most active and successful species in the cultivated areas of Sindh and Punjab. It is serious agriculture pest and also plays a role in ecosystem as food for the carnivorous species.

Table 73: Checklist of the Small Mammals found in the Chotiari Reservoir Areas

Sr. #	Species	Species code	Common Name	Data Source
1	*Meriones hurrianae*	Mh	Indian Desert Jird	Trapped
2	*Tatera indica*	Ti	Indian Gerbil	Trapped
3	*Gerbilus nanus*	Gn	Balochistan Gerbil	Trapped
4	*Bendicota bengalensis*	Bb	Sindh Rice Rat	Trapped
5	*Mus booduga*	Mb	Little Indian Field Mouse	Secondary
6	*Mus musculus*	Mm	House mouse	Trapped
7	*Rattus rattus*	Rr	House Rat	Trapped
8	*Millardia gleadowi*	Mg	Sand-coloured rat	Secondary
9	*Millardia meltada*	Ml	Soft furred field rat	Secondary
10	*Hystrix indica*	Hi	Indian crested porcupine	Trapped
11	*Funambulus pennantii*	Fp	Norther palm Squirrel	Trapped
12	*Lepus nigricolis*	Ln	Indian hare	Trapped
13	*Herpestes edwardsi*	He	Indian Grey Mongoose	Trapped
14	*Herpestes javanicus*	Hj	Small Asian Mongoose	Trapped
15	*Vivericula indica*	Vi	Small Indian Civit	Secondary
16	*Mellivora capensis*	Mc	Honey Badger	Secondary
17	*Scotophilus healthii*	Sh	Common yellow-bellied bat	Secondary
18	*Pipistrellus kuhlii*	Pk	Kuhls' bat	Secondary
19	*Suncus murinus*	Sm	House shrew	Trapped
20	*Hemiechinus collaris*	Hc	Long eared desert Hedge hog	Trapped
21	*Paraechinus micropus*	Pm	Indian hedge hog	Trapped

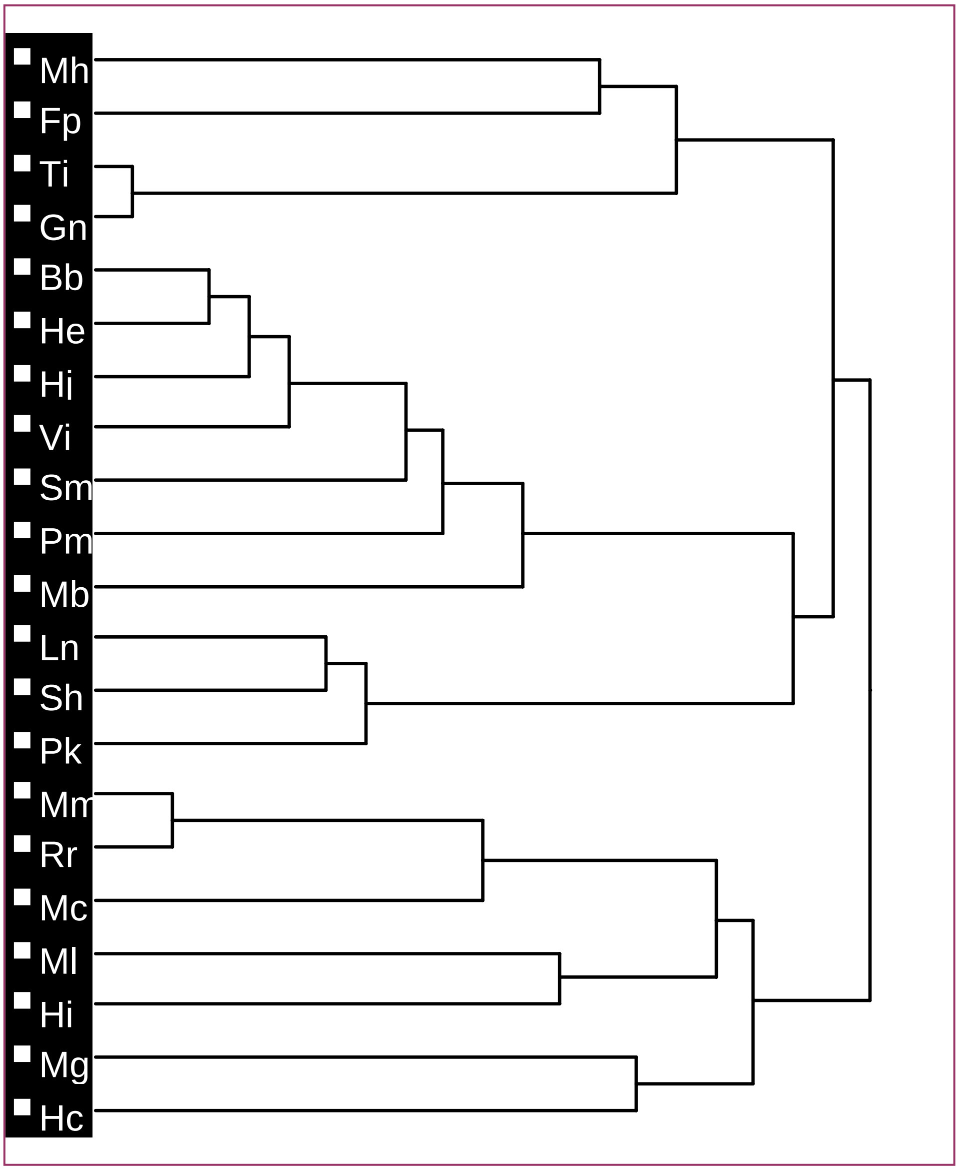


Figure 15: Small Mammals' Species Association in NARA Desert

3.3.3. 3 Discussion

Three species of rodents, viz, *Gerbillus nanus, meriones hurrianae* and *Tatera indica* are the key species of rodents found in the Chotiari reservoir area. The population of these species was found maximum during this time of the year (October). Many reasons can be assigned to this higher population. The small mammals generally build their population during the months of summer especially after the monsoon showers. Their population reaches at its peak during the months of September-October. The reproductive potential of the rodents generally decreases with the onset of winter season and the population is generally minimum in the February. The decrease in hunting pressure as a result of construction activities in the area can be another reason for high level of rodent population.

The rodents are eaten up by a number of animals. They support the life of many carnivores including foxes, wild cats, eagles, jackals, buzzards and snakes. The population of foxes in the area was noted at its minimum at this time of the year and it seems as the hunting pressure has reduced on the small mammals due to construction work of the Chotiari reservoir for the last many years. Consequently, the population of to small mammals at this time of the year was found to be at its maximum.

The rodent population is associated with the type of soil and the type of vegetation in the area. The Gerbellus nanus has a close association with the *Calligonum* bushes. More the *Calligonurn*, more number burrows and hence more number of specimens of this species is observed. The *Tatara indica* and the *Meriones hurrianae* mostly prefer the compact soil with trees and large thick patches of bushes. Generally more rodents are found in the compact soil of low lying areas as it probably has more moisture content in the soil which helps in their survival during the sever heat of the summer. The rolling sand dunes of the desert along the eastern side of the reservoir almost lack any species of small mammals, as it is hard to maintain the burrows in this kind of soil.

The interface areas of the desert and the agricultural fields have the maximum diversity of small mammals. In this area, the small mammal species of the plain areas enter into desert areas to variable extents. The hares, hedgehogs, porcupine, bats, Bandicoot rat, jackals, foxes, mongooses, palm civets, house mouse, shrews Rats etc are all represented in these areas and the diversity keeps on thinning as we enter into the pure desert until only three species of typical rodents is mostly encountered.

Certain species of small mammals have strong associations with each other and presence of even few species can predict the occurrence of the associated fauna. During the present studies, *Meriones hurrianae, Funambulus pennantii, Tatera indica,* and *Gerbellus nanus* are associated with each other. They represent typical desert species and are mostly found together. *Bandicota benghalensis, Herpestes edwardsi, Herpestes javanicus, Vivericula indica, Suncus murinus, Paraecheinus micropus,* and *Mus buduga* form the second assemblage. These species are mainly associated with agriculture desert interface areas. The species *Lepus nigricollis, Scotophilus healthii, Parachinus micropus* are associated with the second assemblage but they also show a separate association. *Millardia meltada, Rattus rattus, Mellivora capensis, Millardia meltada, Hystrix indica, Millardia gleadowi, Hemiechinus micropus* show another loose association and mainly representing agricultural areas.

3.3.4 Reptilian Study

FINDINGS OF THE REPTILIAN STUDY

Mori or pump area of Chotiari dam was surveyed. The area is purely sandy with *xerophytic* habitat. Nearly 100 tracks of the lizard, *Ophiomorus tridactylus* (Indian Sand Swimmer) and nearly 35 tracks of *Acanthodactylus cantoris* (Indian Fringe – Toed Sand Lizard) and four tracks of *Echis carinatus sochureki* (Saw – Scaled Viper) were seen in 0.25 km of sand dune area. The lizard Indian sand swimmer is grouped in the Scincidae family so it is skink. It is nocturnal in habit so in the day time it lives 1 – 2 ft under the sand near bushes of *xerophytic* plants such as *Acacia, Tamarix, Calotropis, Salvadora* sp. At night it becomes active and feeds on different types of insects. Its most preferable food is termite. It is locally named as “Rait Mahi”. Hakims prepare “majoon” and sell it by the name “Majoone – Rait Mahi”. They believe that it increases the strength of muscular organ (Sexual Organ). Photograps of the fresh tracks of this typical lizard have been taken. In the same area two *Varanus bengalensis* (Indian monitor lizard), three *Acanthodactylus cantoris* (Indian Fringe – Toed Sand Lizard), three tracks of non – poisonous snakes were seen. The habitat is quiet suitable for the breeding, shelter and survival of reptilian fauna.

Near Mori or pump area, *Euphlyctis cyanophlyctis* (Skittering Frog) and *Bufo stomaticus* (Marbled Toad) were seen. These frogs and toads are the food of snakes.

The area of Baqar dhand was surveyed. The inside of the dam is thickly covered with tall and dense *Typha, Saccharum, Tamarix, Acacia* sp etc. Due to summer season and excessive heat no crocodile was seen. They were resting under water or hidden inside the thickly covered vegetation. In sufficient quantity of water they are seen swimming or floating in water but at present the dam has not sufficient quantity of water. Four monitor lizards, *Varanus bengalensis* (Indian Monitor Lizard) were seen moving actively. Two *Calotes versicolor* (Indian Garden Lizard) have been seen running and finally climbing on *Acacia* tree. Two fresh water turtles, *Lissemys punctata andersoni* (Indian Flap – Shell Turtle) were seen moving actively. Photographs of this species have been taken for future reference and record.

Padrio area of Chotiari has been visited. This area is purely sandy or desert and is surrounded by high and low sand dunes. The habitat is suitable for breeding, shelter and survival of Reptilian fauna. Here the main plants are *Salvadora* and *Euphorbia*. *Euphorbia* sp is dominant. This plant is very bushy, thick and thorny and provides a good shelter and breeding ground of many reptiles especially for *Echis carinatus sochureki* (Saw – Scaled Viper). Besides reptiles these xerophytic plants also give shelter to small mammals and many insects especially scorpion and beetles. *Salvadora* sp also provides shelter and breeding ground to many lizards. Two *Novoeumeces schneiderii zarudnyi* (Orange – Tailed or Zarudny’s Skink) have been seen running inside the *Salvadora* plant. Large number of tracks of *Ophimorus tridactylus* (Indian Sand Swimmer) was seen. Five fresh tracks of snakes were seen on the sand dunes.

Sanghar (Chotiari area) is the only district of Sindh where endangered species of snake *Python molurus* (Indian Python) has been recorded. In this study no sign of Python has been observed in and around the Chotiari reservoir. The game watcher of Sindh Wildlife Department and villagers say that they still see this large snake. People are afraid of this snake because they kill their domestic animals such as hens, small goats, hare etc. Jogis come in the shape of “Faqeer” and collect the Python in the bag. After killing them they sell their skins.

This was a brief survey of little duration hence the comprehensive data of distribution of Reptilian fauna of Chotiari needs to be collected and detailed survey is organised.

Table 74: Checklist of Reptilian and Amphibian Fauna of Chotiari Reservoir

REPTILES

S. No.	Family	Species	English Name	Local Name	Status
1.	Crocodylidae	Crocodylus palustris	Snub-nosed Crocodile	Wagu, Kumeer, Magarmach	Appendix I in CITES. Also included in IUCN Red Data Book
2.	Agamidae	*Calotes versicolor versicolor*	Indian Garden Lizard	Girgit or Girgitan, Shyee, Kafir Girgit	Common
3.		*Trapelus agilis agilis*	Brilliant Agama	Karrun	Common
4.		*Trapelus megalonyx*	Afghan Ground Agama	Karrun	Common
5.	Gekkonidae	*Crossobamon orientalis*	Sind Sand Gecko	Chuggul, Kerley, Chipkilly	Common
6.		*Cyrtopodion kachhensis kachhensis*	Warty Rock Gecko	Chuggul	Common
7.		*Cyrtopodion scaber*	Keeled Rock Gecko	Chuggul	Common
8.		*Hemidactylus brookii*	Spotted Indian House Gecko	Chhipkali, Chiplee, Chuttee	Common
9.		*Hemidactylus flaviviridis*	Yellow-Bellied House Gecko	Chhipkali, Chiplee, Chuttee	Common
10.		*Hemidactylus leschenaultii*	Bark Gecko	Chhipkali, Chiplee, Chuttee	Common
11.	Lacertidae	*Acanthodactylus cantoris*	Indian Fringe-Toed Sand Lizard	Chhipkali, Chiplee, Chuttee	Common
12.	Scincidae	*Novoeumeces schneiderii zarudnyi*	Zarudny's Skink	Putterguchni, Baamni	Less Common

13.		*Ophiomorus tridactylus*	Afghan Sand Swimmer	Ret mahi, Reg mahi	Common
14.	Uromastycidae	*Uromastyx hardwickii*	Indian Spiny-tailed Lizard	Sandha, Sonder	Appendix II in CITES. Common in Pakistan
15.	Varanidae	Varanus bengalensis	Indian Monitor	Goh or Goh-Pard	Appendix I in CITES, Common
16.		*Varanus griseus koniecznyi*	Indian Desert Monitor	Goh or Goh-Pard	Appendix I in CITES, Less Common
17.	Boidae	*Eryx johnii*	Indian or Common Sand Boa	Do-moi, Do-sar	Common
18.		*Eryx conicus*	Russell's Sand Boa	Do-moi, Do-sar	Less Common
19.	Pythonidae	*Python molurus molurus*	Indian Python	Azdaha, Azdar, Arar	Thretened, Appendix I in CITES, Included in IUCN Red Data List
20.	Colubridae	*Lycodon striatus striatus*	Northern or Spotted Wolf Snake	Aabi – Sangchul	Less Common
21.		*Lytorhynchus paradoxus*	Sindh Awl – Headed Snake		Less Common
22.		*Platyceps ventromaculatus ventromaculatus*	Glossy-bellied Racer	Sagi, Jhari wala Saanp	Common
23.		*Psammophis leithi*	Pakistan Ribbon Snake or Ribbon Snake	Tormar or Thormar	Less Common
24.		*Psammophis condanarus*	Indian Sand snake	Tormar or Thormar	Less Common
25.		*Psammophis schokari*	Afro-Asian Sand Snake or Saharo-Sindhian Ribbon Snake	Tormar or Thormar	Less Common
26.		*Ptyas mucosus*	Dhaman or	Dhaman	Common

			Rope Snake		
27.		*Spalerosophis diadema atriceps*	Royal Snake	Kourar	Common
28.	Elapidae	*Bungarus caeruleus caeruleus*	Indian or Common Krait	Sangchul, Pee – un	Common
29.		*Naja naja*	Indian Cobra or The Cobra	Kala Naag, Naagu, Chamcha Maar	Common
30.		*Naja oxiana*	Oxus Cobra or Brown Cobra	Kala Naag, Naagu, Chamcha Maar	Endangered, included in Red Data List
31.	Viperidae	*Daboia russelii russelii*	Russel's Viper or Chain Viper	Koriala, Khuppar	Common
32.		*Echis carinatus sochureki*	Eastern or Sochurek's Saw-scaled Viper	Loondee, Jalebi, Khuppar	Common
33.	Trionychidae	Lissemys punctata	Indian Flap-shell Turtle	Kachwa	Less Common, Appendix I in CITES

AMPHIBIANS

S. No.	Family	Species	English Name	Local Name	Status
1.	Ranidae	Euphlyctis cyanophlyctis cyanophlyctis	Skittering Frog	Daddu	Common
2.	Bufonidae	Bufo stomaticus	Marbled Toad	Daddu	Common

Ophiomorus tridactylus (Afghan Sand Swimmer)

Crossobamon orientalis (Sindh Sand Gecko)

Faecal Pellets of Crocodile (Chotiari reservoir area)

Uromastyn hardwickii (Indian Sping – Tailed Lizard)Chotiari area

Lissemys punctata (Indian Flap – shell turtle)
Near Mori or pump area, Chotiari

3.3.4.2 Ecological Significance of Crocodile and Python in Chotiari Reservoir

As the species, *Crocodylus palustris* has been listed as endangered in the Red Data Book of IUCN (1975) and Sanghar and Nawabshah districts are the only places in the whole area of Sindh province where this species is still surviving. Besides this there is a very poor population of crocodiles and python at Hingol area of Balochistan province. In the Chotoari eco – system the population of crocodiles is somehow satisfactory due to the availability of preferred habitat and food. This largest reptile is highly demanded throughout the world because of its economic importance and commercial value. Shoes, purses, belts and other useful goods are prepared by its hide. Besides these this species has also medicinal value. Under the suitable conditions required by this species at Chotiari eco – system there is a great chance for their multiplication and the increased population of this endangered species would be helpful in the preparation of the overall environmental master plan. Its proper conservation and management at Chotiari reservoir area will be a great help to the scientists and naturalist of Pakistan as well as to the foreign scientist and naturalist.

3.3.4.3 Estimated Population and Status of Crocodile in & outside Chotiari Reservoir

From the previous surveys undertaken at Chotiari reservoir and personal communication with local fishermen, the estimated population of Crocodile inside and outside of the dam is as follows:

Table 74 A- Estimated population of Crocodile inside and outside of the dam

S. #	Areas Inside the Dam	No. of Crocodiles
1	Seri Dhand	07
2	Jaduper Dhand	-
3	Kanderwari Dhand	06
4	Akhanwari	02
5	Simro Dhand	10
6	Abrao Dhand	-
7	Sadori Dhand	05
8	Jalal Dhand	02
9	Baqar Dhand	100
10	Haranthri Dhand	-
11	Saranwari	02
12	Paksari	20
13	Gangri	-
14	Rehrri	-
15	Sukhyari	-
16	Mahmoodi	-
17	Bholowari	-
18	Padhero	03
19	Talwari	-
20	Phulail area	-
21	Serorra	-
22	Kandar	-
23	Jamer	-
24	Jholwari	-
25	Bakel	-
26	Korki	05
27	Deseji	-
28	Sabarji	-
29	Inamwari	04
30	Sajanwari	02
31	Pakhroi	-
32	Khatonwari	-
33	Saharo	-
34	Hinro	-
35	Nimwari	05
36	Mustaqim	-
37	Badrari	05
38	Ratrao	-
39	Dhorka	-

40	Rerro Dhand	07
41	Khama Dhand	-
42	Sehonri Dhand	-
43	Kinrri Dhand	-
44	Dubbi Dhand	-
45	Rerro Dhand	-
46	Badreo Dhand	-
47	Wacho Dhand	-
48	Kolhen waro	-
49	Dhang Dhand	-
	Areas (Dhands) outside the Dam	**No. of Crocodiles**
50	Rahocho Dhand	-
51	Talawari Dhand	02
52	Gaonwari Dhand	-
53	Barri Dhand	-
54	Sooro Dhand	-
55	Sanrrewari Dhand	-
56	Panehal Dhand	-
57	Nowghuro Dhand	05
58	Dogre Dhand	-
59	Dubri Dhand	-
60	Kalach Dhand	10

3.3.5 Ichthyological Survey

FINDINGS OF THE FISH SURVEY

The Chotiari reservoir is located about 35 Km east of Sanghar town in the area of Makhi along the left bank of Nara canal. The reservoir is situated at the interface of desert in the east and north and agricultural lands in the west and south. On the eastern side, the reservoir extends into Thar Desert in the form of finger like projections. The reservoir is formed of a series of interlinked lakes emerged through filling of natural depressions between the sand dunes. These lakes are surrounded by Nara canal which is a major source of water for these lakes. During rainy and flooding season, these lakes also receive water from Ajo and Ranto escapes Bakar is the biggest lake among them while other important lakes are Gunwari, Tajar, Phulel, Seri and Sao Naro. Initially, the reservoir covered an area of about 37 sq. km. but after the construction of Chotiari reservoir, its area has been increased to about 85 Sq. km. This reservoir is meant to irrigate an area of 150,000 acres of land of Umarkot and Mirpur Khas, especially during dry seasons. The depth of reservoir ranges from 1 to 8 meter. The lake beds consist of sandy, silt and muddy but the water is very clear. One can see the bottom of the lake even in deep waters. These lakes are full of vegetation and floating islands of dead uprooted large patches of *Saccharum* that bear live vegetation right in the middle of lake especially in Phulel area. Due to deep light penetration and high water temperature, the natural productivity of these lakes is very high but at the same time they are prone to eutrophication due to high rate of vegetation decomposition. These lakes have long stretches of shallow waters full of aquatic vegetation mainly the *Typha, Phragmites, Polygonum, Equisetum* and *Riccia*. These areas provide breeding centers for fishes breeding in stagnant waters and nursery grounds for fish fries and fingerlings.

Table 75: Fisheries Resources of the Chotiari Lake

Sr #	Species	Family	Local Name	Commercial value	Status	*Feeding Habits*
1	*Gadusia chapra*	Clupeidae	Palri			
2	*Notopterus notopterus*	Notopteridae	Gandhni	Medium	Common	Carnivore
3	*Chitala chitala*	Notopteridae	Gandhan	High	Less common	Carnivore
4	*Salmophasia bacaila*	Cyprinidae	Sanota	Low	Common	Herbivore
5	*Chela cachius*		Dunnarah			
6	*Securicula gora*	Cyprinidae		Low	Common	Herbivore
7	*Amblypharyngodon mola*	Cyprinidae		Low	Common	Herbivore
8	*Aspidoparia morar*	Cyprinidae		Low	Common	Herbivore
9	*Barilius vagra*	Cyprinidae		Low	Common	Herbivore
10	*Rasbora daniconius*	Cyprinidae		Low	Common	Herbivore
11	*Cirrhinus mrigala*	Cyprinidae	Mirgal, Morakhi	High	Common	Herbivore
12	*Cirrhinus reba*	Cyprinidae	Ganer	Medium	Common	Herbivore
13	*Gibelion catla*	Cyprinidae	Theli	High	Common	Herbivore
14	*Labeo calbasu*	Cyprinidae	Dahi	High	Common	Herbivore
15	*Labeo dyocheilus*	Cyprinidae		Medium	Common	Herbivore

Sr #	Species	Family	Local Name	Commercial value	Status	*Feeding Habits*
	pakistanicus					
16	*Labeo gonius*	Cyprinidae	Sario	Medium	Common	Herbivore
17	*Labeo rohita*	Cyprinidae	Ruhu, Kurro	High	Common	Herbivore
18	*Labeo dero*	Cyprinidae		Medium	Common	Herbivore
19	*Osteobrama cotio*	Cyprinidae	Makhni	Low	Common	Omnivore
20	*Puntius sophore*	Cyprinidae	Popri	Low	Common	Herbivore
21	*Puntius ticto*	Cyprinidae	Popri	Low	Common	Herbivore
22	*Systomus sarana*	Cyprinidae	Khirni	Low	Common	Herbivore
23	*Cyprinus carpio*	Cyprinidae	Carp	High	Common	Herbivore
24	*Sperata sarwari*	Bagridae	Seengharo	High	Common	Piscivore
25	*Mystus cavasius*	Bagridae	Tengra	Low	Common	Carnivore
26	*Mystus bleekri*	Bagridae	Tingaran	Low	Common	Carnivore
27	*Mystus tengara*	Bagridae	Tingaran	Low	Common	Carnivore
28	*Gagata cenia*	Sisoridae				
29	*Rita rita*	Sisoridae	Kago	High	Rare	Carnivore
30	*Bagarius bagarius*	Sisoridae	Barim	High	Less common	Piscivore
31	*Ompok bimaculatus*	Siluridae	Pafta	Low	Common	Carnivore
32	*Wallago attu*	Siluridae	Jerki	High	Common	Piscivore
33	*Heteropneustes fossilis*	Heteropneustidae	Loora	Medium	Common	Carnivore
34	*Clupisoma garua*	Chilbeid.ae	Dongna	High	Less common	Carnivore
35	*Xenentodon cancila*	Xenentodontidae	Kang	Medium	Very common	Carnivore
36	*Channa marulia*	Channidae	Sole	High	Common	Carnivore
37	*Channa punctata*	Channidae	Shakur	Medium	Common	Carnivore
38	*Chanda nama*		Kandar	Medium	Very common	Omnivore
39	*Aplocheilus panchax*	Aplocheilidae	JHingra	Low	Common	Omnivore
40	*Ailia coila*	Schilbeidae	Batasi			
41	*Parambasis baculis*	Chandidae	Kandar	Low	Very common	Omnivore
42	*Parambasis ranga*		Kandar	Low	Very common	Omnivore
	Colisa faciata	Osphronernidae	Kangi	Low	Common	Carnivore
43	*Glossogobius giuris*	Gobidae	Gulla	Medium	Common	Carnivore
	Sicamugil cascasia	Mugilidae	Mugil	Low	Common	Omnivore
44	*Oreochromis mossambicus*		Daya	High	Very common	Omnivore
45	*Mastacembelus armatus*	Mastace.mbelidae	Goj	Medium	Very common	Carnivore

Tilapia mosambiqa

Cirrhinus mrigala

Labeo rohita

Wallago attu

Notopterus notopterus

Labeo gonius

Gudusia chapra

Labeo gonius

3.3.6 Avi Fauna Survey

FINDINGS OF THE AVI FAUNA STUDY:

There were very limited number of water birds present in the Chotiari reservoir and only 67 species of birds were observed and most of these were distributed over the areas. There was a moderate population of Glossy Ibis that was not actually observed in the reserve but observed in the cultivated land (rice) near Gojri village.

Table 76: Birds recorded at Chotiari are given below:

No	Common name	Scientific name	Absence/presence from first survey	Population estimates from second survey	Status
1	Little Grebe	*Tachybaptus ruficollis*	Y	10-50	Resident
2	Black Necked Grebe	*Podiceps nigricollis*	N	<10	Migrant
3	Large Cormorant	*Phalcrocorax carbo*	N	50-100	Migrant
4	Little Cormorant	*Phalcrocorax niger*	Y	550-1000	Resident
5	Grey Heron	*Ardea cinerea*	N	<10	Migrant
6	Purple Heron	*Ardea purpurea*	N	<10	Resident
7	Little egret	*Egretta garzetta*	Y	550-1000	Resident
8	Intermediate Egret	*Egretta intermedia*	N	10-50	Resident
9	Large Egret	*Egretta alba*	N	10-50	Resident
10	Pond Heron	*Ardeola grayii*	y	200-250	Resident
11	Cattle egret	*Bubulcus ibis*	Y	350-400	Resident
11	Night Heron	*Nycticorax nycticorax*	N	<10	Resident
12	Common Coot	*Fulica atra*	N	450-500	Migrant
13	Shoveller	*Anas clypeata*	N	10-27	Migrant
14	Common Teal	*Anas crecca*	N	100-150	Migrant
15	Mallard	*Anas platyryhnchos*	N	10-50	Migrant
16	Northern Pintail	*Anas acuta*	N	50-100	Migrant
17	Gallinule	*Gallinula chloropus*	Y	10-50	Resident
18	Purple Moorhen	*Porphyrio porphyrio*	N	<10	Resident
19	Pheasant tail Jacana	*Hydrophasianus chirurgus*	N	<10	Resident
20	Little tern	*Sterna albifrons*	Y	10-50	Resident
21	River Tern	*Sterna aurantia*	Y	50-100	Resident
22	Black Headed Gull	*Larus ridibundus*	N	50-100	Migrant
23	Brown Headed Gull	*Larus brunnicephalus*	N	<10	Migrant
24	Curlew	*Numenius arquata*	N	<10	Migrant
25	Red Shank	*Tringa totanus*	Y	250-300	Migrant
26	Marsh Sand Piper	*Tringa stagnatilis*	Y	10-50	Migrant
27	Green Shank	*Tringa nebularia*		<10	Migrant
28	Green Sandpiper	*Tringa ochropus*	Y	10-50	Migrant
29	Common Sand Piper	*Actitis hypoleucos*	Y	<10	Migrant

30	Little Stint	*Calidris minuta*	Y	100-150	Migrant
31	Ruff	*Philomachus pugax*	N	10-50	Migrant
32	Little Ringed plover	*Charadrius dubius*	Y	10-50	Migrant
33	Black winged Stilt	*Himantopus himantopus*	Y	300-350	Resident
34	Red-Wattled Lapwing	*Vanellus indicus*	Y	10-50	Resident
35	House Swift	*Apus affinis*	Y	150-200	Resident
36	Eurasian Kingfisher	*Alcedo atthis*	Y	<10	Resident
37	White-breasted Kingfisher	*Halcyon smyrnensis*	Y	<10	Resident
38	Pied Kingfisher	*Ceryle rudis*	Y	10-50	Resident
39	Sand Martin	*Riparia riparia*	Y	400-450	Resident
40	House Swallow	*Hirundo rustica*	Y	150-200	Resident
41	Glossy Ibis	*Plegadis falcinellus*	Y	<10	Migrant
42	White Breasted water Hen	*Amaurornis phoenicurus*	Y	N	
43	White Pelican	*Pelecanus onocrotalus*	N	<10	Migrant
44	Black-bellied tern	*Sterna acuticauda*	Y	n/a	Migrant
45	White wagtail	*Motacilla alba*	Y	n/a	Migrant
46	Yellow headed wagtail	*Motacilla citreola*	Y	n/a	Migrant
47	Yellow wagtail	*Motacilla flava*	Y	n/a	Migrant
48	Lapwing	*Vanellus indicus*	Y	n/a	Resident
49	Marsh harrier	*Circus aeruginosus*	Y	n/a	Migrant
50	Crow pheasant	*Centropus sinensis*	Y	n/a	Resident
51	Graceful Prinia	*Prinia gracilis*	Y	n/a	Resident
52	Plain Prinia	*Prinia inornata*	Y	n/a	Resident
53	Dusky Eagle Owl	*Bubo coromandus*	Y	n/a	Resident
54	Flame-backed woodpecker	*Dinopium benghalense*	Y	n/a	Resident
55	Jungle Babbler	*Turdoides striata*	Y	n/a	Resident
56	Grey Shrike	*Lanius excubitor*	Y	n/a	Resident
57	Black Partridge	*Francolinus francolinus*	Y	n/a	Resident

58	Grey Partridge	*Francolinus pondicerianus*	Y	n/a	Resident
59	Tree Sparrow	*Passer sp*	Y	n/a	Migrant
60	Cetti's warbler	*Cettia cetti*	Y	n/a	Resident
61	Parakeet	*Psittacula krameri*	Y	n/a	Resident
62	Bee eater	*Merops orientalis*	Y	n/a	Resident
63	Rosy Startling	*Sturnus vulgaris*	Y	n/a	Migrant
64	Black Redstart	*Phoenicurus ochruros*	Y	n/a	Resident
65	Red collard turtle dove	*Streptopelia tranquebarica*	Y	n/a	Resident
66	Eurasian collared dove	*Streptopelia decaocto*	Y	n/a	Resident
67	Purple sunbird	*Nectarinia asiatica*	Y	n/a	Resident

Out of a total of 67 species there were 33 migrants and 34 resident birds observed at the area of Chotiary reservoir. Disturbance to birds due to hunting near “Phulel” village was observed. Thirteen hunted coots were seen near the village.

Certainly Chotiari had more diversity in terms of forest birds and a very good population of partridge was recorded. According to the locals the birds are afforded protection by the local landlords who presumably hunt them. In addition to this there were good population of dove species and migratory rosy starlings and sparrow species were observed in good numbers.

3.3.7 Limnological Study

FINDINGS OF THE LIMNOLOGICAL STUDY:

3.3.7.1 Water sample analysis:

The survey was conducted in the November 2006. Salinity was recorded as 0.10 ppm, pH between 7.1 - 7.2, Total Dissolved Solids ranged between 156-178 mg/L, Total Suspended Solids ranged between 940-1135 mg/L, Biochemical Oxygen Demand between 178-195 mg/L, Chemical Oxygen Demand between 268-282 mg/L, Phenol values ranged between 0.042-0.056 mg/L, Nitrate between 0.45-0.86 mg /L, Cadmium ranged between 0.15-0.21 and no Chromium was found in the sample. Oil and Grease value was obtained as 210 mg/L (Table 77).

3.3.7.2 Planktons:

- **Phytoplanktons**: The phytoplanktons are identified from the samples belonging to the phyla of Cyanophyta, Chlorophyta, Euglenophyta, Pyrrophyta, Xanthophyta and Bacillariophyta. Twenty species belonging to cynophyta, 13 species belonging to phylum Bacillariophyta (Diatoms), 9 species from chlorophyta, 4 species from Euglenophyta, 3 species from xanthophyta and 1 species from pyrrophyta recorded from Chotiari reservoir. Cynophyta species are the indication of presence of high level of silica in water (Table 78).
- **Zooplanktons**: There were two phyla of zooplanktons identified from the samples which were Rotifera and Arthropoda. Altogether 11 species identified from the samples from which 3 belongs to order ploima, 2 belong to order copepoda, 1 from calanoida and 5 from cladocera (Table 79).

3.3.7.3 Macro invertebrates:

Marco invertebrate belong to phylum Mollusca, Class Gastropoda with 1 individual of *Lymnaea stagnails* (Table 80).

Table 77: Physical Chemical parameter analysis at Chotiari Reservoir:

Parameters mg/L	Sampling Stations					NEQS (Rev.)
Physical parameters	**ST-1**	**ST-2**	**ST-3**	**ST-4**	**ST-5**	
pH	7.2	7.1	7.1	7.2	7.1	6-9
Temperature °C	26.10	25.60	25.60	26.80	26.40	40 °C=<3 °C
Salinity $^0/_{00}$	0.10	0.10	0.10	0.10	0.10	
Total dissolved solids (TDS)	156	158	178	162	172	3500
Total suspended solids (TSS)	952	940	968	1100	1135	200
Chemical parameters						
Biochemica - l oxygen demand (BOD_5)	193	192	195	190	178	80
Chemical oxygen demand (COD)	268	272	276	275	282	150
Phenol	0.042	0.056	ND	ND	ND	0.1
Nitrate	0.86	0.45	0.79	0.66	0.83	50
Cadmium (Composite)	0.021	0.015	ND	ND	ND	0.1
Chromium (Composite)	Nil	Nil	ND	ND	ND	1.0
Oil and grease (n-Hexane extract)	210	ND	ND	ND	ND	10

ND = Not Done

Table 77 A: Pesticide analysis:

Sampling Site	Pesticide µg/L (BDL)			
	Malathione	Cypermetherine	Aldrin	Dialdrin
Keenjhar lake	-ve	-ve	-ve	-ve
Keti Bunder	-ve	-ve	-ve	-ve
Chotiari Reservoir	-ve	-ve	-ve	-ve

Table 77 B: Pesticide analysis:

Sampling Site	Pesticide µg/L (BDL)		
	Acetempride	Acetempride	Myaline
Keenjhar lake	-ve	-ve	-ve
Keti Bunder	+ve	-ve	+ve
Chotiari Reservoir	-ve	+ve	-ve

BDL= Below Detection Limit
+ve = Present
-Ve =Absent

Table 78: Checklist of Phytoplankton (algae) recorded at Chotiari Reservoir.

Stations	1	2	3	4	5
Phylum: Cyanophyta					
Class: Chroocophyceae					
Order: Chroococcales					
Family: Chroococcaceae					
Chroococcus tenax (Kirch.) Hier	-	+	-	+	+
Cylindrospermum staganale Kutz.	+	-	-	-	+
Gloeocapsa magma (Bereb.) Holl	+	-	+	+	+
Gomphosphaeria aponina Kutz.	+	-	-	+	+
Gomphosphaeria aponina	+	-	+	+	-
Merismoped glauca Ehrenbnag Nag	+	+	+	+	+
Merismopedia tenuissima Lemm.	+	+	+	+	+
Microcystes robusta (Clard) Nygaard	+	-	-	+	-
Xenococcus kerneri Hansg.	-	+	+	+	++
Class: Nostocophyceae					
Order: Nostocales					
Family: Nostocaceae					
Anabaena variabilis Kuetzing	+	-	+	+	+
Family: Oscillatoriaceae					
Oscillatoria amphibia Ag.	+	+	+	+	+
Oscillatoria formosa	+	+	+	+	+
Oscillatoria jasorvensis Vouk.	-	+	-	-	+
Oscillatoria limosa Ag.	+	+	-	-	-
Oscillatoria limosa Ag. Ex. Goment	+	-	-	+	+
Oscillatoria principes W.et G.S.West	+	-	-	+	+
Oscillatoria princips Vauch	+	+	+	+	+
Oscillatorria formosa Bory.	+	+	+	+	+
Oscillatoria amphibia Ag	+	+	+	+	-
Spirulena princeps W.et G.SWest	+	+	-	-	-

Stations	1	2	3	4	5
Phylum:Chlorophyta					
Class: Chlorophyceae					
Order: Chlorococcales					
Family: Oocystaceae					
Oocystis borgei Srrow.	-	+	+	-	-
Sphaerocystis schroeteri Chod.	+	+	-	-	-
Family: Scenedesmaceae					
Ankistrodesmus acicularis	+	+	+	+	+
Family: Hydrodictyaceae					
Pediasterium clathratum (Schroeter) Lemm.	++	+	-	-	-
Pediastrium sp.	+	-	-	-	-
Pediastrum tetras (Ehr) Berb.	+	+	+	+	+

Order:Zygnematales					
Cosmarium blyttii Will	+	+	-	-	+
Cosmarium deprassum Nag. Lund	+	-	-	+	+
Cosmarium graminatum Brebission.E	-	-	-	+	+
Phylum: Euglenophyta					
Class: Euglenophyceae					
Order: Euglenales					
Family: Euglenaceae					
Coccomonas orbicularis Stein.	-	+	+	+	+
Euglena deses Ehrenb.	+	-	+	-	+
Euglena spirogyra Ehrenb.	+	-	-	+	+
Lepocinclis longistriata Chu.					
Division: Pyrrophyta					
Perinidium elpatiewskyi (Qstenf.) Lemm.	+	-	-	+	+
Division: Xanthophyta					
Botryococcus braunii Kutz.	+	-	-	+	+
Centritractus belonophorus (Sch.) Lemm.	+	+	+	-	+
Tribonema affine G.S. west.	+	-	+	+	-
Phylum: Bacillariophyta					
Class: Bacillariophyceae					
Anomoeoneis sphaerophora (Kutz.) Pfitz.	+	+	+	+	+
Asterionella formosa Hass.	-	-	+	+	+
Order: Centrals					
Family: Coscinoiscoideae					
Cymbella affinis Kutz.	+	-	+	+	-
Cymbella gracilis (Rabens.) Cl.	+	-	-	-	+
Fragilaria capucina Desmazi.	+	-	+	+	+
Gomphonema parvulum var. subelliptica CL.	+	-	+	-	+
Gyrosigma kutzingii (Grun.) Cl.	-	+	-	+	+
Navicula anglica	+	-	-	-	+
Nitzschia palea (Kutz.) W. Smith	+	-	+	-	+
Pinneularia nobilis Ehr.	+	-	+	-	-
Navicula pupula Var. rectangularis (Greg) (Grun.)	+	+	+	+	+
Rhoicosphenia curvata (Kutz) Grun.	+	+	+	-	+
Tabellaria fenestrata (Lyngb.) Kutz.	+	+	+	+	-

(-)Absent
(+) Present

Table 79: Numbers of zooplanktons recorded at Chotiari Reservoir.

Stations	1	2	3	4	5
Phylum: Rotifera					
Class: Monogonota					
Order: Ploima					
Family: Brachionidae					
Brachionus caudatus	0	0	0	22	4
Keratella tropica	37	2	56	3	9
Monostyla bulla	6	4	3	9	17
Phylum: Arthropoda					
Class: Crustacea					
Order: Copepoda					
Suborder: Cyclopoida					
Mesocyclops leuckerti	0	69	0	0	24
Cyclops nupli	34	0	26	0	36
Suborder: Calanoida					
Family: Diaptomidae					
Heliodiaptomus sp.	3	4	6	0	0
Suborder: Cladocera					
Family: Bosminidae					
Bosimina coregoni	6	56	9	3	2
Bosmina fatalis	2	1	0	78	0
Bosmina longirostris	13	48	7	1	2
Family: Daphnidae					
Ceriodaphnia reticulate	4	0	17	0	0
Diaphanosoma sarsi	0	24	3	0	29

Table 80: Checklist of zoobenthos (Dead shells of mollusks) recorded at Chotiari Reservoir.

Stations	1	2	3	4	5
Phylum: Mollusca					
Class: Gastropoda					
Subclass: pulmonata					
Order: basommatophora					
Family: Lymnaeidae					
Lymnaea stagnalis (Linnaeus)	-	2	-	-	-

(-)Absent
(+) Present

3.3.7.4 Discussion

In this present baseline study the aquatic habitat assessment was focused to the planktons and macro biota with physico-chemical analysis of water. The diversity index and relative abundance were use to determine the water quality and overall situation for other aquatic fauna and flora of Kinjhar Lake, Chotiari reservoir and Keti Bunder.

- **Water quality:**

During the survey the pH was within the range of 7 which is also acceptable. The water quality was alkaline in nature *i.e.* more basic. As pH of water is important because many biological activities can occur only within a narrow range (Shepherd & Bromage 1992). Oxygen plays very important role in determining the potential biological quality of water (Lloyd 1992). In the present study the high value of Biological Oxygen Demand indicates the non suitable environment for the aquatic life in three sites. Phenol and its derivatives which are present in many industrial effluents must be specifically treated because of their toxicity to the aquatic life and ecosystems (Table 77).

The high value of total suspended solids indicates the excessive amount of organic matter which is harmful for the aquatic life. The low values of chromium and cadmium indicting the water is not contaminated by heavy metals. Acceptable amount of phenol is present in the study area (Table 77).

Oil and grease present in the water samples are in high values which may be due to the mechanized boats used in the the site (Table 77).

- **Pesticides**

Pesticides that are soluble in both water and fats are usually taken up more quickly by man and animals as the traces of these pesticides along with their metabolites and break down products are ubiquitously present in abiotic and biotic environment (Tiel 1972). Negative results for commercially used pesticides shows that the there are no traces of commercially exploited pesticides in the three sites (Annexure 2). However, further analysis showed the presence of the other pesticides namely Acetemride and Myalin in the samples of Chotiari Reservoir (Table 77, A & B).

- **Relative Abundance:**

In Chotiari Reservoir the zooplanktons were abundant as compared to phytoplankton. The R.A % of phytoplankton was calculated as 19.3 % and for zooplankton as 80.64 %. The cynophyta was dominant followed by chlorophyta and euglenophyta (Table 81 & 82).

The R.A of *Lymnaea stagnails* for macro invertebrates was 40% (Table 83).

- **Diversity Indices:**

Diversity indices are good indicator of pollution in aquatic ecosystem (Mason 1998). The values are less than 1 indicating the polluted condition as described by Mason (1988). The values in the range of 1-3 are characteristics of moderately polluted conditions and values less than 1 characterize heavily polluted condition and the value greater than 3 indicates the clean water and good for biological life.

In Chotiari reservoir the diversity index indicates the condition which is moderately polluted for the cynophyta, chlorophyta and bacillariophyta. The diversity Index shows polluted condition for the euglenophyta pyrrophyta and xanthophyta wherease in zooplankton it showed the water condition is polluted.

Table 81: Diversity Index and Relative Abundance recorded at Chotiari Reservoir.

CHOTIARI RESERVOIR

Groups of Planktons Recorded	No. of Genera – (S)	Total # of individuals (N)	In N	Diversity Index = S-1/ In N	Relative Abundance R.A = # of individuals x 100 Total #
Phytoplankton					
Cynophyta	11	71	4.28	2.33	43.55
Chlorophyta	5	26	3.25	1.23	15.95
Euglenophyta	3	10	2.30	0.86	6.13
Pyrrophyta	1	3	1.09	0	1.84
Xanthophyta	3	10	2.30	0.86	6.13
Bacillariophyta	11	43	3.76	2.65	26.38
Total		**163**			
Zooplanktons Orders					
Ploima (Rotifera)	3	172	5.14	0.38	25.33
Copepoda (Arthopoda)	2	189	5.24	0.19	27.8
Calanoida (Arthopoda)	1	13	2.5	0	1.91
Cladocera (Arthopoda)	1	305	5.72	0	44.91
Total		**679**			
Total number of planktons		**842**			

Table 82: Comparison of Relative Abundance of Phytoplankton and Zooplankton at Chotiari Reservoir.

	Chotiari Reservoir
Number of Phytoplankton	163
Number of Zooplankton	679
Total Number of Organisms	842
R.A of Phytoplankton %	19.3%
R.A of Zooplankton %	80.64%

Table 83: Relative Abundance of Macrofauna at Chotiari Reservoir:

S.No.	Classification		No. of individuals	Relative Abundance % R.A = # of individuals x 100 / Total # of individuals
	Chotiari Reservoir			
	Phyllum Class Sub class Order Family Genus	MOLLUSCA GASTROPODA PLUMONATA BASOMMATOPHORA LYMNAEIDAE Lymnaea		
	Species	*Lymnaea stagnalis* (Linnaeus)	2	50%
Total			2	

Figure16: Relative Abundance of Phytoplankton at Chotiari Reservoir

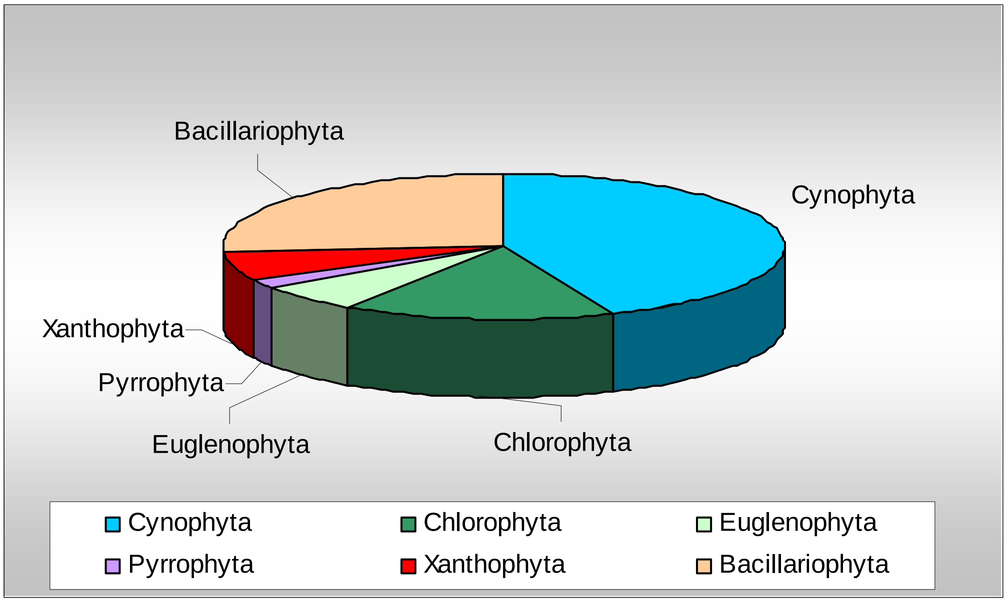


Figure 17: Relative Abundance of Zooplankton at Chotiari Reservoir

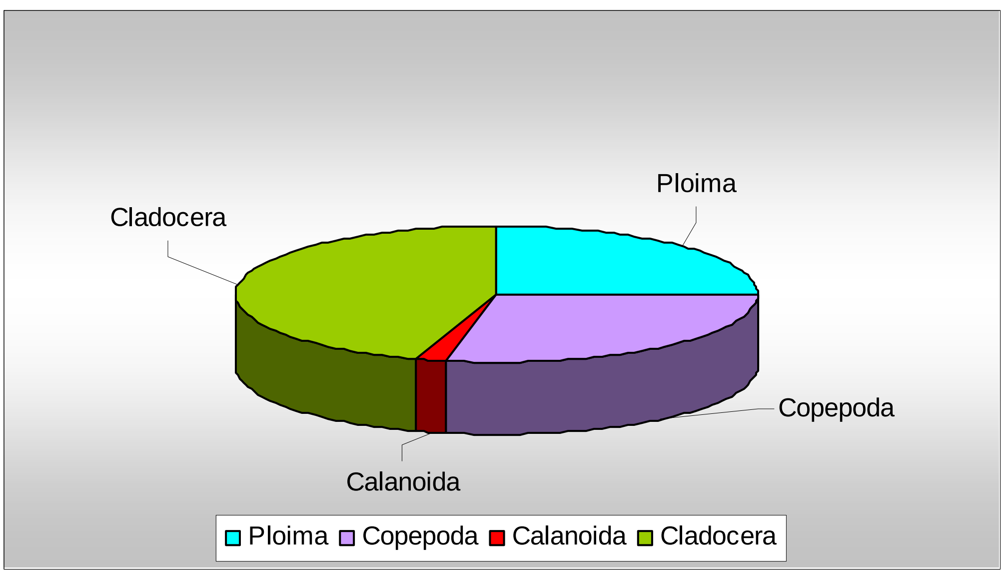
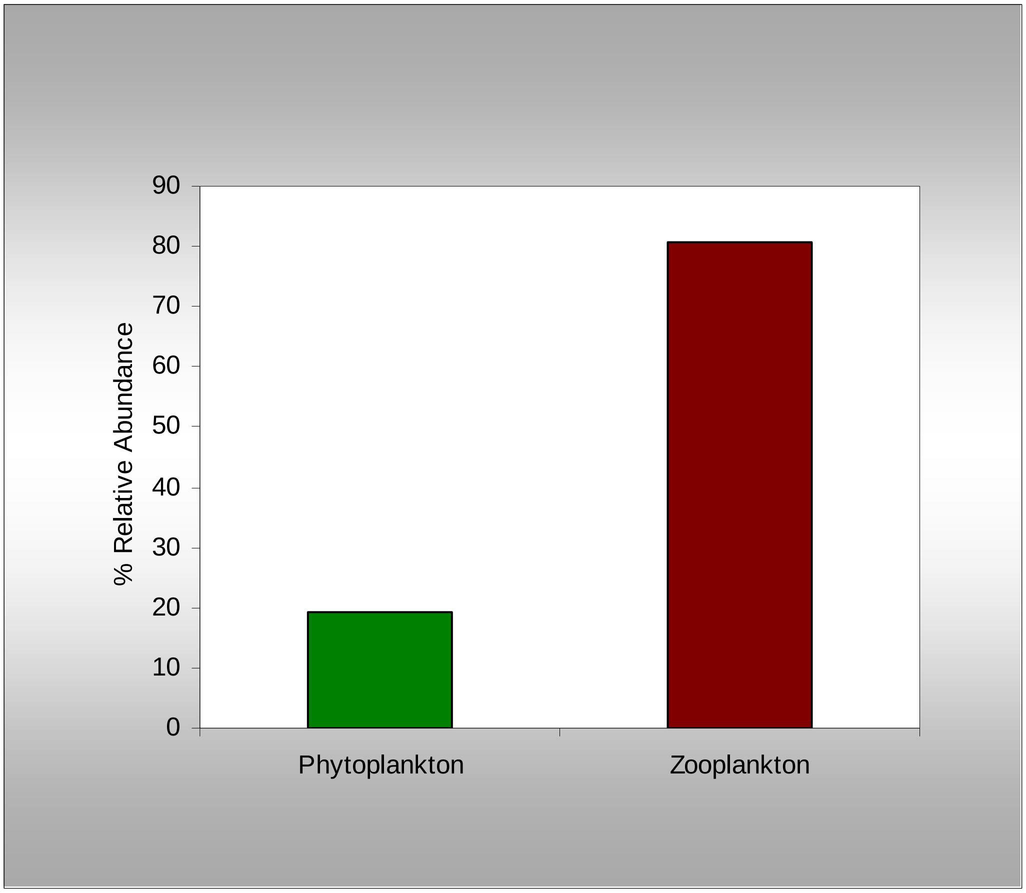


Figure 18: Relative Abundance of Plankton at Chotiari Reservoir



3.4 - Pai Forest

3.4.1 Natural Vegetation Assessment

FINDINGS OF NATURAL VEGETATION STUDY:

The plant communities recorded from Pai Forest is given in the following Table.

Table 84: Assessment of Plant Communities in Pai Forest (Quadrate Size: 50 m x 50 m)

QUAD. NO	COORDINATES		REL COVER (%)	REL. FREQ (%)	REL. DENSITY (%)	I.V	SDR	PLANT COMMUNITY
Q1	**26^{O} 05' 38.3" N 68^{O} 18' 01.5" E**	***SALVADORA PERSICA***	**0.8**	**12.39**	**1.9**	**13.81**	**4.60**	***P. CINERARIA***
		S. OLEOIDES	**0.3**	**15.09**	**0.9**	**15.72**	**5.24**	
		PROSOPIS CINERAIRIA	**21.8**	**22.52**	**54.6**	**62.57**	**20.86**	
		P. JULIFLORA	**7.1**	**22.52**	**17.8**	**35.61**	**11.87**	
		CAPPARIS DECIDUA	**8.4**	**20.05**	**21.1**	**35.50**	**11.83**	
		CADABA FARINOSA	**1.5**	**7.43**	**3.7**	**10.11**	**3.37**	
Q2	**26^{O} 04' 48.6" N 68^{O} 13' 13.0" E**	***P. CINERARIA***	**3.0**	**31.06**	**29.9**	**43.99**	**14.66**	***CAPPARIS – PROSOPIS CINERARIA***
		TAMARIX INDICA	**0.5**	**3.42**	**4.7**	**5.47**	**1.82**	
		P. JULIFLORA	**2.2**	**31.06**	**22.3**	**40.69**	**13.56**	
		C. DECIDUAS	**4.2**	**27.64**	**42.2**	**45.88**	**15.29**	
		T.APHYLLA	**0.1**	**6.83**	**0.9**	**7.24**	**2.41**	
		P. CINERARIA	**3.0**	**31.06**	**29.9**	**43.99**	**14.66**	
Q3	**26^{O} 05' 8" N 68^{0}13' 08.7" E**	***P. JULIFLORA***	**0.2**	**32.15**	**12.5**	**36.57**	**12.19**	***PROSOPIS CINERARIA***
		CAPPARIS. DECIDUA	**0.2**	**28.62**	**12.5**	**33.03**	**11.01**	
		P. CINERAIA	**1.2**	**32.15**	**62.5**	**54.23**	**18.08**	
		EUCALYPTUS CAMALDULENSIS	**0.2**	**7.07**	**12.5**	**11.49**	**3.83**	
Q4	**26^{O} 05' 26.9" N 68^{O} 13' 31.1" E**	***P. CINERARIA***	**51.5**	**47.39**	**68.7**	**121.84**	**40.61**	***PROSOPIS CINERARIA***
		P. JULIFLORA	**21.9**	**47.39**	**29.2**	**79.03**	**26.34**	
		DESMOSTACHYA	**1.6**	**5.21**	**2.1**	**7.49**	**2.50**	

Q5	**26^{O} 05’ 48.8” N 68^{O} 13’ 39”.5 E**	***ACACIA NILOTICA***	**43.7**	**2.61**	**53.39**	**64.07**	**21.36**	***ACACIA – P. JULIFLORA***
		P. JULIFLORA	**28.3**	**23.70**	**34.64**	**63.57**	**21.19**	
		E. CAMALDULENSIS	**0.4**	**5.21**	**0.52**	**5.81**	**1.94**	
		C. DECIDUAS	**5.5**	**21.09**	**6.77**	**28.88**	**9.63**	
		T. APHYLLA	**1.7**	**5.21**	**2.08**	**7.61**	**2.54**	
		P. CINERARIA	**1.7**	**23.70**	**2.08**	**26.10**	**8.70**	
		Z. NUMMULARIA	**0.2**	**2.61**	**0.26**	**2.91**	**0.97**	
		S. OELOIDES	**0.2**	**15.88**	**0.26**	**16.18**	**5.39**	
Q6	**26 06 12.4 N 68 15 21.7 E**	***C. DECIDUA***	**4.0**	**21.09**	**6.12**	**27.17**	**9.06**	***P. CINERARIA***
		P. JULIFLORA	**16.0**	**23.70**	**24.18**	**47.74**	**15.91**	
		P. CINERARIA	**19.5**	**23.70**	**29.45**	**52.97**	**17.66**	
		S. OLEOIDES	**1.8**	**15.88**	**2.70**	**18.56**	**6.19**	
		S. PERSICA	**0.9**	**13.03**	**1.42**	**14.45**	**4.82**	
		CALOTROPIS PROCERA	**23.9**	**2.61**	**36.13**	**38.53**	**12.84**	
Q7	**26 06 20.6 N 68 !6 44.7 E**	***P. CINERARIA***	**18.6**	**0.02**	**14.81**	**46.04**	**15.35**	***PROSOPIS JULIFLORA***
		P. JULIFLORA	**57.8**	**0.07**	**46.09**	**95.68**	**31.89**	
		C. DECIDUA	**4.1**	**0.05**	**31.41**	**34.64**	**11.55**	
		S. PERSICA	**5.2**	**0.01**	**4.12**	**18.92**	**6.31**	
		S. OLEOIDES	**3.4**	**0.004**	**2.74**	**19.44**	**6.48**	
		CADABA FARINOSA	**1.0**	**0.001**	**0.82**	**8.74**	**2.91**	
Q8	**26 05 37.0 N 68 16 09.3 E**	***P. JULIFLORA***	**24.33**	**20.0**	**37.55**	**56.89**	**18.96**	***PROSOPIS JULIFLORA***
		P. CINERARIA	**24.33**	**15.1**	**28.22**	**48.80**	**16.27**	
		S. PERSICA	**13.38**	**0.3**	**28.10**	**23.01**	**7.67**	
		C. DECIDUA	**21.65**	**2.2**	**3.68**	**25.11**	**8.37**	
		S. OLEOIDES	**16.30**	**2.4**	**2.45**	**19.48**	**6.49**	
Q9	**26 05 22.6 N 68 15 41.1 E**	***P. CINERARIA***	**56**	**22.52**	**69.72**	**101.72**	**33.91**	***PROSOPIS JULIFLORA***
		P. JULIFLORA	**18**	**22.52**	**22.83**	**48.46**	**16.15**	

		S. OLEOIDES	**2**	**15.09**	**1.95**	**17.31**	**5.77**	
		C. DECIDUA	**2**	**20.05**	**1.83**	**22.62**	**7.54**	
		S. PERSICA	**1**	**12.39**	**1.83**	**13.68**	**4.56**	
		CADABA FARINOSA	**1**	**7.43**	**1.83**	**9.12**	**3.04**	

3.4.1.1 Conclusion

Pai Forest does not represent any natural ecosystem in Indus Ecoregion rather it is a man-made forest which harbours Hog deer because of good refuge. It was declared Game Reserve primarily to provide hunting opportunities of partridges to hunters. Since it is a safe abode of Hog deer and interest of Forest and Wildlife Departments for its sustainable conservation, this site could be included in IFAP. However, it would be advisable to choose a minimum representative area of natural Riverine ecosystem for rehabilitation and conservation. This could be done in close consultation with the Sindh Forest Department.

3.4.1.2 Summary of Pai Forest Flora

Vegetation assessment of Pai Forest was carried out from 23rd September and then on 17th October, 2006. Some 62 plant species belonging to 49 genera and 26 families are identified. Of them, 7 grasses (Poaceae family) have been identified. The major plant families which contributed in the formation of vegetation in the area in question are Amaranthaceae (11.29%), Poaceae (11.29%) followed by Malvaceae (6.45%), Capparidaceae (6.45%), Tiliaceae (6.45%), Aizoaceae (4.84%), Euphorbiaceae (4.84%), Mimosaceae (4.84%), Tamaricaeae (4.84%) and Compositae (3.23%). The alphabetical checklist of species along their family, vernacular names and life form/habit is provided (Table 82).

Figure 19: Contribution of Different Plant Families to Overall Flora of Pai Forest

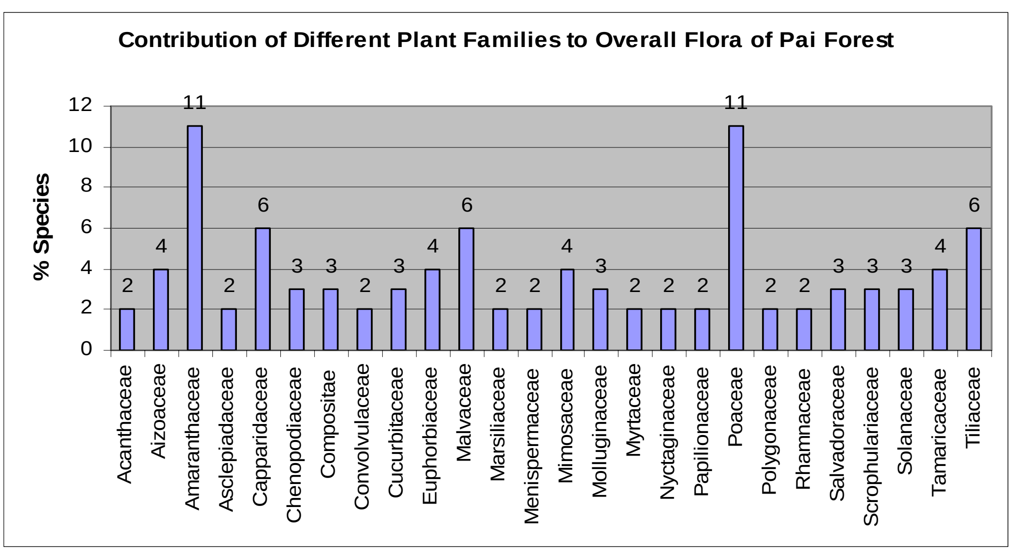


Table 85: List of plant species along with their families, vernacular names and life form of Pai Irrigated Plantation.

	Family	Plant species	Life form	Habit
1	Acanthaceae	*Peristrophe paniculata* (Forssk) Brummit	Therophyte	Herb
2	Aizoaceae	*Trianthema crystallina* (Forsk) Vahl	Therophyte	Herb
03	Aizoaceae	*Trianthema portulacastrum* L.	Therophyte	Herb
04	Aizoaceae	*Zaleya pentandra* (L.) Jeffery.	Chamaephyte	Herb
05	Amaranthaceae	*Achyranthes aspera* L.	Phanerophyte	Subshrub
06	Amaranthaceae	*Aerva javanica* (Burm.f.) Juss.	Phanerophyte	Subshrub
07	Amaranthaceae	*Alternanthera sessilis* (L.) DC.	Chamaephyte	Shrub
08	Amaranthaceae	*Amaranthus graecizans* L.	Therophyte	Herb
09	Amaranthaceae	*Amaranthus viridis* L.	Therophyte	Herb
10	Amaranthaceae	*Digera muricata* (L.) Mart.	Therophyte	Herb
11	Amaranthaceae	*Nothosaerva brachiata* (L.) Wight	Therophyte	Herb
12	Asclepiadaceae	*Calotropis procera* (Willd.) R. Br.	Phanerophyte	Shrub
13	Capparidaceae	*Cadaba fruticosa (*L.) Druce,	Phanerophyte	Shrub
14	Capparidaceae	*Capparis decidua* (Forsk.) Edgew.	Phanerophyte	Shrub
15	Capparidaceae	*Cleome brachycarpa* Vahl ex DC.	Chamaephyte	Herb
16	Capparidaceae	*Dipterygium glaucum* Dcne.	Phanerophyte	Subshrub
17	Chenopodiaceae	*Salsola imbricata* Forsk.	Phanerophyte	Shrub
18	Chenopodiaceae	*Suaeda fruticosa* Forsk. ex J.F.Gmelin	Phanerophyte	Shrub
19	Convolvulaceae	*Convolvulus prostratus* Forssk.	Chamaephyte	Herb
20	Compositae	*Eclipta prostrata* (L.) L.	Chamaephyte	Herb
21	Compositae	*Launaea procumbens* (Roxb.) Amin	Chamaephyte	Herb
22	Cucurbitaceae	*Cucumis melo* L. var *agrestis* Naud.	Chamaephyte	Climber
23	Cucurbitaceae	*Mukia maderaspatensis* (L.) M.J. Roem.	Phanerophyte	Climber
24	Euphorbiaceae	*Euphorbia prostrata* Ait.	Therophyte	Herb
25	Euphorbiaceae	*Euphorbia serpens* Kunth	Therophyte	Herb
26	Euphorbiaceae	*Phyllanthus faternus* Webster	Therophyte	Herb
27	Malvaceae	*Abutilon bidentatum* A. Rich	Phanerophyte	Subshrub
28	Malvaceae	*Abutilon indicum* (L.) Sweet	Phanerophyte	Subshrub
29	Malvaceae	*Abutilon theophrastii* Medic.	Phanerophyte	Subshrub
30	Malvaceae	*Pavonia sp*	Phanerophyte	Subshrub
31	Marsiliaceae	*Marsilia minuta* L.	Hydrophyte/Fern	Herb
32	Menispermaceae	*Cocculus hirsutus* (L.) Diels	Phanerophyte	Vine
33	Mimosaceae	*Acacia nilotica* Delile	Phanerophte	Tree
34	Mimosaceae	*Prosopis cineraria*(Linn.) Druce.	Phanerophyte	Tree
35	Mimosaceae	*Prosopis juliflora* (Swartz) DC.	Phanerophyte	Shrub
36	Molluginaceae	*Glinus lotoides* L.	Therophyte	Herb
37	Molluginaceae	*Mollugo pentaphylla* L.	Chaemophyte	Herb
38	Myrtaceae	*Eucalyptus camaldulensis*	Therophyte	Tree
39	Nyctaginaceae	*Boerhavia procumbens* Banks & Roxb.	Cryptophyte	Herb
40	Papilionaceae	*Rhynchosia minima* (L.) DC.	Chamaephyte	Climber
41	Poaceae	*Brachiara ramose* (L.) Stapf	Therophyte	Herb
42	Poaceae	*Dactyloctenium aegyptium* (L.) P. Beauv.	Therophyte	Grass
43	Poaceae	*Desmostrachya bipinnata* (L.) Stapf	Hemicryptophyte	Grass
44	Poaceae	*Echinochloa colona* (L.) Link	Therophyte	Herb
45	Poaceae	*Eragrostis japonica* (Thunb.) Trin.	Therophyte	Grass
46	Poaceae	*Eragrostis minor* Host.	Therophyte	Grass
47	Poaceae	*Setaria verticillata* (L.) Beauv.	Therophyte	Grass

48	Polygonaceae	*Polygonum effusum* Meisn	Therophyte	Herb
49	Rhamnaceae	*Zizyphus nummularia* (Burm.f.) Wt.	Phanerophyte	Shrub
50	Salvadoraceae	*Salvadora oleoides* Dcne.	Phanerophyte	Tree
51	Salvadoraceae	*Salvadora persica* L.	Phanerophyte	Tree
52	Scrophulariaceae	*Lindenbergia indica* (L.) Vatke	Therophyte	Herb
53	Scrophulariaceae	*Verbascum thapsus* L.	Therophyte	Herb
54	Solanaceae	*Physalis peruviana* L.	Therophyte	Herb
55	Solanaceae	*Solanum surattense* Burm.f.	Therophyte	Herb
56	Tamaricaceae	*Tamarix aphylla* (L.) H. Karst.	Phanerophyte	Tree
57	Tamaricaceae	*Tamarix kermanensis* Baum	Phanerophyte	Tree
58	Tamaricaceae	*Tamarix indica* L.	Phanerophyte	Tree
59	Tiliaceae	*Corchorus aestuans* L.	Therophyte	Herb
60	Tiliaceae	*Corchorus depressus* (L.) Stocks	Chamaephyte	Herb
61	Tiliaceae	*Corchorus tridens* L.	Therophyte	Herb
62	Tiliaceae	*Corchorus trilocularis* L.	Therophyte	Herb

3.4.1.3 Biodiversity Index & Species Richness:

I. **α-Diversity** (i.e., the species richness and species diversity within each locality). With reference to species richness, Kinjhar Lake surroundings have shown the highest α-diversity with a total of 41 plant families, 104 genera and 136 species, followed by Chotiari with 40 families, 82 genera, and 116 species, Pai forest with 27 families, 51 genera, and 64 species; and Keti Bunder with 19 families, 32 genera and 39 species.

Among various families, Gramineae exhibited the highest species richness in Kinjhar, Chotiari, and Pai; whereas in Keti Bunder Chenopodiaceae showed the highest diversity followed by Gramineae. This is indicative of the high salinity of the Keti Bunder area. Besides Chenopodiaceae, other halophytes/salt tolerant species include *Avicennia marina, Aeluropus lagopoides, Sporobolus virginicus* and three species of *Tamarix.*

II. **β-Diversity** (i.e., the species turnover from one locality to other locality or diversity between localities)

Localities were compared in pairs with every possible combination. The highest number of species was shared by Kinjhar and Chotiari, i.e., these two localities had 57 species in common, followed by Chotiari – Pai with 30 species in common, Kinjhar-Pai with 30 species in common, Kinjhar-Keti with 27 species in common, and Keti-Chotiari with 13 species in common, and Keti-Pai with 12 species in common.

These localities pairs showed similarity index likewise.

Table 86: Similarity Index and β-diversity of study sites

Localities pairs	Similarity index (CC)	*β-diversity
1. Keti-Kinjhar	0.308	1.691
2. Keti-Chotiari	0.168	1.832
3. Keti-Pai	0.233	1.767
4. Kinjhar-Chotiari	0.452	1.548
5. Kinjhar-Pai	0.30	1.700
6. Chotiari-Pai	0.333	1.667

* Inversely proportional to similarity index.

Only 8 species were found to be shared by all localities, among which the notorious alien species *Prosopis juliflora* was most prominent.

III. **γ-Diversity** (i.e., diversity of all localities collectively).

The total number of species of all the four localities came to be 241. However, this number is liable to increase in future with more detailed surveys in different parts of the year.

3.4.2 Large Mammals Assessment

FINDINGS OF MAMALIAN FAUNA SURVEY:

Number of Species

Four species of Large Mammals belonging to 2 Orders and 4 Families were recorded from the area, as given in Table 87.

Table 87: List of Large Mammals recorded at Pai Forest

S. No.	Order	Family	Scientific Name	English Name	Urdu Name	Sindhi Name
1	Carnivora	Canidae	*Canis aureus*	Asiatic Jackal	Geedar	Giddarr
2		Felidae	*Felis chaus*	Jungle Cat	Jangli Billi	Jhangrarr Billo, Ban Bilar
3	Artiodactyla	Bovidae	*Sus scrofa*	Wild Boar	Jangli Suar	Suar
4		Cervidae	*Axis porcinus*	Hog Deer	Para	Pharra

3.4.2.1 Summary of Individual Species

Asiatic Jackal *(Canis aureus)*

Although, estimation of their population was not done but they are common in the forest. Their frequent barking calls were heard from almost all the corners of the forest.

Jungle Cat *(Felis chaus)*

They are fairly common in the forested area. They are the enemy of partridges and prey upon it for feeding. Therefore, the Wildlife Department's staff used to kill the jungle cat as and when they were encountered previously. Now they have realized that it is the part of the ecosystem and thus have stopped this practice. But 'Bagri' tribe of Sindh traps this animal from even this area. This tribe eats its flesh.

Wild boar *(Sus scrofa)*

They forage at night in the agricultural field within the forest and outside the forest periphery. The agriculturists in general are the enemy of this animal and kill/shoot it when encountered. We did not observe it but evidences like foot prints were seen. Its density/population was not estimated, but it is the only species of ungulates which is common and considered as pest to agricultural crops. They are not hunted, rather killed or shot down for being an agricultural pest. They do not have any natural predator as well.

Hog Deer (Axis *porcinus*)

Survey of Hog deer was conducted in detail during 1st and 3rd November 2006 and its report is being given here separately.

3.4.2.2 Status of Hog Deer (*Axis Porcinus*) In Pai Forest, Nawab Shah, Sindh.

Pai forest covers an area of about 4777 acres and divided into 140 small compartments of 40 hectare each. Out of 140 compartments, 34 were found to be the potential sites for the existence of Hog deer. Out of these 34 potential sites, 27 were marked as high density areas while 9 compartments, as the low density areas by the officials of Sindh Wildlife and Forest Departments. In total, 12 compartments were studied for the estimation of Hog deer in the forest; nine compartments from high density areas and 3 compartments from low density areas.

The first objective of the study was to confirm the existence of Hog deer in the forest. It was achieved by various direct and indirect evidences that included; direct sighting of the animals in two different compartments, presence of foot prints and fecal droppings and photographic evidences of wounded animals by hunting dogs and accidentally killed on the road.

The second objective of the study; the population estimation of hog deer, was achieved by applying various techniques of population estimation and different direct and indirect observation methods. It was estimated that there are around 6 pairs of Hog deer in the forest and in total 18 animals including the young ones.

A list of food plants of Hog deer is also included along with the botanical names. Various threats to hog deer in the forest are mentioned and a few suggested measures are also given at the end.

HOG DEER
Hog deer belonging to order Artiodactyla and Family Cervidae, is a nocturnal animal with a stocky appearance and shorter legs.

General Characteristics
Body length: 105-115 cm / 3.5-3.8 ft. Shoulder Height: 60-75 cm / 2-2.5 ft. Tail length: 18-20 cm / 7-8 in. Weight: 36-50 kg / 79-110 lb. Gestation period: 180 days. Young per birth: 1, rarely 2, Weaning: At about 6 months. Sexual Maturity: At 8-12 months. Life Span: Up to 20 years.

The coat is an ochre-brown color, although adult males generally darken with age. The youngs are spotted with white freckles and reminiscent faint spots may be visible in the summer coat of adults. There is a darker band running down the spine. Built as a creeper, the Hog deer has relatively short legs and a stocky figure which is lower in the front than the back. The face is short and wedge-shaped. Males bear three-tined antlers, mounted on short pedicels on the forehead, which may grow up to 60 cm / 24 inches in length. The mating season peaks from September to December depending upon the region (Huffman 2004).

Ecology and Behavior

The term “Hog deer” is derived from this deer’s habit of running through the forest with its head held low, ducking under obstacles in the manner of a wild hog (pig), rather than leaping over them like most deer. Hog deer is not a social animal and lives a solitary existence, although in regions where they are plentiful it is possible to see several animals feeding in the same vicinity. The main social group is a female and her fawn. When alarmed, Hog deer make a whistling vocalization or a warning bark. Hog deer can swim well and readily enter the water so that they often take up temporary abode on islands between the channels of the Indus (Roberts1997).

Home ranges vary widely in size, but average about 70 hectares (7 km). Males are aggressive and may become territorial at low population densities, marking the boundaries with glandular secretions. During the rut, males gather in open meadows, pawing the ground during antagonistic encounters. Harems are not created, with males courting and defending a single female at any given time. Unlike many other deer species, Hog deer do not have a rutting call. Population densities may be as low as 0.1 animals per square kilometer in riverine valleys, rising to over 19 individuals per square kilometer in grassy floodplains.

The preferred habitat for Hog deer are thickets of *Tamarix* and *Saccharum* along Indus River. This ungulate was once common in the riverine forests along Indus and Nara but now very rare everywhere as a result of shrinking habitat. Ahmed (1997) reported its occurrence in Rajhari, Kethi sahu, Khaddi and Nara, as well as few surviving around Suleimanki Headworks on Sutlej and Batapur on Ravi. Scott (1989) reported its occurrence in adjacent areas of some major wetlands.

A map of the study area is included in the report showing various compartments in the forest, locations of the installed tube wells, locations of the beat areas, location of those compartments where there is a pressure on Hog deer through hunting dogs, areas of high density population and low density population of Hog deer and the compartments where hog deer were directly seen and foot prints were observed.

3.4.2.3 Results And Discussions

Confirmation of the Existence of Hog Deer in Pai Forest:

On the basis of following evidences, the existence of hog deer was confirmed in the study area.

1. Direct sighting of the animals at two different locations in the forest *i.e.* compartment number 57 and 64.
2. Presence of fresh foot prints, about 1-2 days older, in 12 different compartments of the study area (No. 16, 23, 40, 46, 53, 57, 65, 67, 70, 73, 81 and 92) during line transacts.
3. Presence of faecal droppings at four different locations in the study area (Compartments No. 40, 53, 57 and 65).
4. Photographic evidences of two different animals, one male and one female, wounded by hunting dogs about two months before the survey.
5. Photographic evidence of an accidentally killed animal on National Highway near the forest.

Foot prints of Hog deer

Pallets of hog deer

Female killed by dogs

Male wounded by dogs

Female killed by dogs

3.4.2.4 Estimates of Existing Population of Hog Deer in Pai Forest

Point Surveys

During point surveys, total 5 Hog deer were sighted at two different locations.

- Two Hog deer (1 male and 1 female) in early morning at 6:20 am in compartment number 64 which crossed over to compartment number 65.
- Three Hog deer (1 male, 1 female and 1 young) in the evening, about 45 minutes after sunset in compartment number 57 near cultivated area of the compartment.

Roadside Counts

No animal could be seen during travelling at night along different inter-compartmental tracks inside the forest for two consecutive nights.

Track Counts

During 12 transects in 12 different compartments of the forest, foot prints of 32 animals were counted. Each transects covering an area of 0.05 km² (length of transect = 0.5 km, width of transect = 0.1 km). These foot prints were about 1-2 days older and the foot prints older than 2 days were not counted.

Table 88: Track counts of Hog Deer

Transect Number	Compartment Number	Foot prints observed	Total
1	16 HD	F 2, Y 1	3
2	23 HD	M 1, F 1	2
3	40 HD	F 1, Y 1	2
4	46 LD	F2, Y 2	4
5	53 HD	M 1, F 1, Y 1	3
7	57 HD	M 1, F 1	2
6	65 LD	M 1, F 1, Y 1	3
8	67 HD	M 1, F 1, Y 2	4
9	70 LD	M 1, F 1	2
10	73 HD	M 1, F 1	2
11	81 HD	M 1, F 1, Y 1	3
12	92 HD	M 1, F 1	2
		TOTAL	**32**

(M = male, F = female, Y = young, HD = high density, LD = low density)

Out of 140 compartments, 34 compartments (No. 7, 8, 9, 10, 11, 16, 17, 18, 23, 24, 25, 26, 29, 35, 37, 38, 39, 40, 41, 46, 53, 56, 57, 58, 65, 67, 70, 73, 74, 76, 81, 92, 95 and 97), were reported by wildlife watchers as the potential sites for the existence of Hog deer. As Pai forest is a game reserve, out of the 34 compartments, 27 compartments (No. 7, 8, 9, 10, 11, 16, 17, 18, 23, 24, 25, 26, 38, 39, 40, 41, 53, 56, 57, 58, 67, 73, 74, 76, 81, 95 and 97) are those where beat areas are prepared for partridge hunting by cutting the trees and converting an 8 acres' square area as agricultural land in each of these 27 compartments. These 27 compartments are considered as high density areas for Hog deer. Rest of the 7 compartments (No. 29, 35, 37, 46, 65, 70 and 92) are considered as low density areas for Hog deer as there is a hunting pressure of tamed hunting dogs. To assess the Hog deer population, 12 compartments were searched by using line transect methods. Out of these 12 compartments, 9 compartments (No. 16, 23, 40, 53, 57, 67, 73, 81, and 92) were among high density areas and 3, (No. 46, 65, and 70), among low density areas.

In 12 representative compartments of the forest, foot prints of 32 animals were observed including males, females and young ones. It means 32 animals are present in 12 compartments at an average of 2.6 animals per compartment and about 90 animals in 34 potential sites in the forest and even more in the whole forest area. But it does not seem true. In the table of foot prints, 6 types of different herds are prominent with the following composition;

Type 1.	F 2, Y 1 = 3,	one herd
Type 2.	F 2, Y 2 = 4,	one herd
Type 3.	F 1, Y 1 = 2,	one herd
Type 4.	M 1, F 1 = 2, M 1, F 1 = 2, M 1, F 1 = 2, M 1, F 1 = 2, M 1, F 1 = 2,	five herds
Type 5.	M 1, F 1, Y 1 = 3, M 1, F 1, Y 1 = 3, M 1, F 1, Y 1 = 3,	three herds
Type 6.	M 1, F 1, Y 2 = 4,	one herd

According to the composition of herds, there are 4 herds of 3 animals, 6 herds of 2 animals, and 2 herds of 4 animals.

Keeping in view all the factors like habitat conditions, hunting pressure, availability of food, movements of locals in the forest, wood cutting practices, and based on point surveys, road side counts, pellets counts and track counts, it is assumed that there are at a maximum of six pairs of Hog deer in the forest and including the yearlings, in total 18 animals in Pai forest.

Keeping in mind the average home range of Hog deer, about 7 km, and other disturbances in the forest like hunting with dogs, threatening shooting noise during partridge hunting, continuous human interruption in its habitat in the forest during livestock grazing and wood cutting practices etc., it can be assumed that these are the same 18 animals present in the forest which are wandering in about 20 km^2 area of the forest for their survival.

In almost all the compartments searched, foot prints of a pair were observed along with a young but the faecal droppings were found only at 4 locations in 12 compartments (No. 40, 53, 57, and 65). This also suggests that the same six pairs are moving around in the forest. Hunting pressure with dogs from northern, southern and western sides of the forest, as marked in the map, also supports the view that same animals are moving around.

This small population of Hog deer is restricted inside the forest because, surviving out side the forest, is very difficult while there is a tremendous hunting pressure by dogs and live trapping practices by humans. Whenever an animal by chance, crosses the boundary of the forest, it gets either trapped or hunted.

Different cultivated crops like wheat, Guwar and Junter, and some naturally growing plants like Chibhar, Swari, Ikkar, Naro, Babool (*Acacia nilotica*), Nar naro and Mundhari provide sufficient food for hog deer in the forest

Although males show territorial behavior at low population density areas, but 140 compartments, each of 40 hectares, and about 14 compartments provided each with a large cultivated area, a tube well for water supply and being partially separated from other such compartments by inter-compartmental roads, provide enough room for about 6 males to mark and defend an isolated territory.

Hog deer is not a social animal and lives a solitary existence, although in regions where they are plentiful it is possible to see several animals feeding in the same vicinity. The main social group is a female and her fawn.

Wood cutting is a common daily practice in the forest. One can daily observe a number of local people cutting woods in various compartments. This kind of disturbance in the habitat of Hog deer also supports the view of constant movement of a limited population of Hog deer in the forest.

3.4.3 Reptilian Study

FINDINGS OF THE REPTILIAN STUDY:

Reptilian and Amphibian survey of in and around the Pai forest was conducted. Here *Acacia, Prosopis, Eucalyptus* and *Calotropis* species are found. *Eucalyptus* sp is dominant which has been planted every where so Pai forest does not look like natural forest. The area is very dry so this place is not much suitable for many species of Reptiles and Amphibians. Only three *Bufo stomaticus* (Marbled Toad) were seen on the muddy surface where water flows for irrigation. Two lizards, *Hemidactylus leschenaultii* (Bark Gecko) were seen climbing on the tree of *Acacia* sp. One casted skin of Cobra was collected from the bush. Three tracks of Monitor Lizard, *Varanus bengalensis* (Indian Monitor Lizard) were recorded. Tracks of *Echis carinatus* (Saw – Scaled Viper) were also observed on the soft sandy ground.

TABLE 89: Checklist of Reptilian and Amphibian Fauna of Pai Forest

REPTILES

S. No.	Family	Species	English Name	Local Name	Status
1.	Agamidae	*Calotes versicolor versicolor*	Indian Garden Lizard	Girgit or Girgitan, Shyee, Kafir Girgit	Common
2.		*Trapelus agilis agilis*	Brilliant Agama	Karrun	Common
3.		*Trapelus megalonyx*	Afghan Ground Agama	Karrun	Common
4.	Gekkonidae	*Cyrtopodion kachhensis kachhensis*	Warty Rock Gecko	Chuggul	Common
5.		*Cyrtopodion scaber*	Keeled Rock Gecko	Chuggul	Common
6€.		*Hemidactylus brookii*	Spotted Indian House Gecko	Chhipkali, Chiplee, Chuttee	Common
7.		*Hemidactylus flaviviridis*	Yellow-Bellied House Gecko	Chhipkali, Chiplee, Chuttee	Common
8.		*Hemidactylus leschenaultii*	Bark Gecko	Chhipkali, Chiplee, Chuttee	Common
9.	Lacertidae	*Acanthodactylus cantoris*	Indian Fringe-Toed Sand Lizard	Chhipkali, Chiplee, Chuttee	Common
10.		*Ophisops jerdonii*	Punjab	Chhipkali,	Common

			Snake-eyed Lacerta	Chiplee, Chuttee	
11.	Uromastycidae	*Uromastyx hardwickii*	Indian Spiny-tailed Lizard	Sandha, Sonder	Appendix II in CITES. Common in Pakistan
12.	Varanidae	Varanus bengalensis	Indian Monitor	Goh or Goh-Pard	Appendix I in CITES, Common
13.	Colubridae	*Platyceps ventromaculatus ventromaculatus*	Glossy-bellied Racer	Sagi, Jhari wala Saanp	Common
14.		*Psammophis condanarus*	Indian Sand snake	Tormar or Thormar	Less Common
15.		*Ptyas mucosus*	Dhaman or Rope Snake	Dhaman	Common
16.		*Spalerosophis diadema atriceps*	Royal Snake	Kourar	Common
17.	Elapidae	*Bungarus caeruleus caeruleus*	Indian or Common Krait	Sangchul, Pee – un	Common
18.		*Naja naja*	Indian Cobra or The Cobra	Kala Naag, Naagu, Chamcha Maar	Common
19.		*Naja oxiana*	Oxus Cobra or Brown Cobra	Kala Naag, Naagu, Chamcha Maar	Endangered, included in Red Data List
20.	Viperidae	*Daboia russelii russelii*	Russel's Viper or Chain Viper	Koriala, Khuppar	Common
21.		*Echis carinatus sochureki*	Eastern or Sochurek's Saw-scaled Viper	Loondee, Jalebi, Khuppar	Common
22.	Trionychidae	Lissemys punctata	Indian Flap-shell Turtle	Kachwa	Less Common, Appendix I in CITES

AMPHIBIANS

S. No.	Family	Species	English Name	Local Name	Status
1.	Bufonidae	Bufo stomaticus	Marbled Toad	Daddu	Common

3.4.4 Avi Fauna Survey

FINDINGS OF THE AVI FAUNA SURVEY:

Pai forest was visited only once and for a very short amount of time. During this time only a few of bird species were observed which are listed below:

Table 90: List of Birds from Pai Forest

No	Common name	Scientific name	Status
1	Jungle Babbler	*Turdoides striata*	Resident
2	Grey Shrike	*Lanius excubitor*	Resident
3	Purple sunbird	*Nectarinia asiatica*	
4	Parakeet	*Psittacula krameri*	Resident
5	Green Bee eater	*Merops orientalis*	Resident
6	Red collard turtle dove	*Streptopelia tranquebarica*	Resident
7	Eurasian collared dove	*Streptopelia decaocto*	Resident

Pai certainly has the potential to provide good habitat for forest birds. However, the habitat is being degraded at such a rate that it is unlikely to support a diversity of species especially breeding residents.

SECTION 4

ISSUES & THREATS

4.1- KETI BUNDER:

Indus Delta, in general and Keti Bundar, in particular are of great ecological and economic significance because of the mangrove ecosystems they occupy. These ecosystems almost entirely support shrimp fishery that earns 100 million US $ annually (Saifullah 1997). Normally mangrove ecosystems are pristine and do not require much management unless ecological processes are disrupted. In spite of overwhelming importance of mangroves, little attention has been paid to their management in Pakistan. Mangroves are disappearing at an alarming rate and main causes of such rapid decline are rooted among unawareness among policy makers, authorities and public at large (Saifullah 1997). Keti Bundar is one of the major towns in Indus Delta that is facing a multitude of environmental degradation and loss of livelihood opportunities for the locals. A few of the social and environmental problems are briefly summarized below.

Decreased Indus River Flow: This is probably the most serious problem of Indus Delta as a whole. Mangroves occur preferably in deltaic regions of the world because they grow better in low salinity water and soft alluvial substrate. Their productivity increases proportionately with the increase of fresh water (Saifullah 1997). There has been a continuous decrease in Indus River discharge ever since the creation of Pakistan mainly because of extension in irrigated agriculture that forced to construct more upstream dams and barrages. Flow of River Indus has decreased from 150 MAF (before construction of dams) to a meager amount of 10 MAF. Gradual decrease in fresh water has triggered the salinity which is about 40 ppm at many places in the delta region. Such hyper salinity conditions also seriously decline mangroves growth. Moreover, decreased river flow resulted in less deposition of nutrient-rich alluvium. According to Saifullah (1997), the annual alluvial flow has decreased from 200 million tons in 1955 to 50 million tons at Kotri during 1984. Such decline in sediment is also hampering the mangroves growth.

Sea Water Intrusion: Sea intrusion is the main problem that has degraded both underground and surface freshwater resources. Seawater has encroached into the creeks, delta, and channels causing the soil salinity of adjacent lands to exceed cultivable limits. Potable water has become scarce and wells that yielded freshwater a few years ago have turned brackish. The natural vegetation is also under stress due to hyper salinity and change of habitat. The fresh water and brackish water ecosystems have changed to marine ecosystem. In areas that do not have saline ground water, hand pumps constitute another source of fresh water. Unfortunately, Keti Bundar has no fresh water sources and people face serious problems for their day to day requirements.

Pollution: Keti Bundar lacks any system of sewage water and solid waste disposal. Hence the area is heavily polluted. Aga Khan Planning & Building Services (AKPBS) has recently provided soak pit latrines to some households. In nearby cultivable lands the farmers are widely using pesticides and chemical fertilizers. The impacts of these chemicals have never been studied in the creeks. Similarly, the communities use unhygienic polluted water for human consumption, brought from the distances. Water borne diseases like diarrhoea, dysentery and hepatitis are common. Malaria is also commonly reported.

Education: There is only one middle school for boys. Parents, thus either send their children to far-flung areas for further schooling or they quit their further education. There is no facility for female education.

Grazing and Harvesting of Mangroves: There is tremendous pressure of deforestation on mangroves. Camel grazing is widely prevalent in Chan creek and parts of Hajamro creek. Camels are generally owned by Jat tribe mainly as a source of income from their sale. According to estimates, there are about 16000 camels and 11000 cattle which survive on mangroves in Indus Delta (Qureshi 1993, Saifullah 1997). In creeks of Keti Bundar 6000 camels entirely depend on mangrove fodder. Other kind of livestock such as buffaloes and cows are also present. A lot of buffaloes were seen grazing openly at Khobar.

Large scale wood cutting is a common scene

Camels in Chann Creek

Crowns of *A. marina* trimmed nicely by camels

Local communities cut mangroves for fodder and fuel also. According to an estimate 173 kg of wood is used per month per household (Saifullah 1997). Scenes of severe deforestation are common every where as one approach in Chann creek. As told by the local people, big boats transport the wood to elsewhere near Karachi where mangrove wood is sold as fuel wood.

Local fishermen and surrounding communities in major creeks use mangrove wood for fuel. According to Hoekstra *et al.* (1997), the boat-based fishermen use about 53 to 120 kg wood for each fishing trip that lasts for 1 to five days. Wood collection for domestic use for permanent settlements depends very much on the proximity of the settlement to the mangrove vegetation and the availability of alternate sources of wood fuel or energy. In Port Qasim area, about one maund (40 kg) mangrove wood was estimated to be used by each household per day. Mangrove wood is also used for commercial purposes.

Hoekstra *et al.* (1997) provided following details for multiple uses of mangrove wood in Indus Delta region.

Table 91: Uses of wood by fishermen communities in Indus Delta

Harvest Purpose	Shah Bundar	Kharochan	Keti Bundar	East Karachi	Port Qasim
For sale	-	-	Xxx	Xxx	Xx
During fishing	X	X	X	X	X
For domestic use	X	Xxx	X	X	Xxx

Xxx = significant quantity xx = medium quantity x = small quantity

Stray dogs: Stray dogs are serious problem at Keti Bunder town mainly because of availability of abundant fish. Dogs of surrounding habitations also come at Keti Bunder and then become serious problem for the local population.

4.1.1 Fisheries Problems at Keti Bunder

A-General Situation:

- Overall reduction in the flow of the River Indus over recent decades has negatively affected fisheries in estuarine areas of Pakistan. The production of commercially important species such as river shad ‘Palla’, Barramundi ‘Dangri’ and Indian threadfin ‘Rawans’ has decreased substantially in the past four decades. The famous Palla fish has become nearly extinct. The annual production has reduced from 5000 tons in 1951 to just 170 tons in the present years, besides marked reduction in its size. In the past fishermen could catch 300-400 kg shrimps during a fishing trip but presently, despite whole day fishing activity, the catch is hardly 8-10 Kg. For long trips of 20-25 days they only catch 100 kg of shrimps but in the past they could catch 1,000 kg. within four to five days. The production of Jaira shrimps, which are the largest and prized category, has fallen down from 10,000 tons in 1971 to 5,000 tons in 1998. The catch of Kalri has also dropped from 7,500 tons in 1972 to 6,204 in 1998. It has resulted in socio-economic hardships in coastal communities.
- There has been a progressive reduction in the volume of silt from 200 million tons/ year in 1947 to 36 million tons per year in 1991. This has resulted in the erosion and degradation of the Delta and consequent seawater intrusion besides the harmful effects on fisheries, specially shrimp and mangrove forests due to loss of nutrients.
- At least 10 thousand families (with at least 8 to 10 family members per house hold) have migrated due to increasing poverty and land degradation.
- About one million people have lost the jobs engaged in fishing and other businesses. People are starving and more than 100,000 families have migrated to city areas.

B-Over-exploitation of resources:

Mechanization of the fishing fleet and increased demand of seafood for export and domestic consumption have led to increased fish production. However, inadequately managed, it has added a tremendous pressure on natural fisheries stocks. Some of the resources have been depleted. Some are currently over-exploited, while others are under threat of depletion. Shrimp stocks have been severely over-fished and a major decrease in landings of important shrimp species as well as a major reduction in the size of commercial species is now noticeable. Resources of lobsters have already been over-fished and annual landings have decreased from over 5,000 MT to about 800 MT. Resources of crabs, ivory shells and some fin-fishes have also shown signs of over-exploitation.

No stock assessment survey has been carried out for the last 15 years, and the lack of information on the present status of various resources in shallow and offshore waters makes impossible the implementation of appropriate management measures. In the absence of regular monitoring of the resources, it is not possible to determine appropriate levels of exploitation of commercially important species.

C- Over population

One of the major causes of over fishing is the overpopulation of fisher folk as evident in the table below. Fishing families are extended families with a maximum of 25 and minimum of nine members in the family. Due to lack of alternative livelihood, the youngsters find their livelihood in sea resources. This puts pressure on the fisheries resources. Moreover, with the spoilage of agricultural lands and banana gardens, as a result of sea intrusion, the people adapted fishing as their profession. Further more, migrants from other areas of Pakistan and the neighbouring countries have also adapted this profession. All these practices resulted in an increase in fishing boats and fishing intensification.

Table 92: Trends in the increase of fishermen engaged in fishing practices in the coastal areas.

Year	No. of Fishermen
1995-96	111,938
1996-97	112,000
1997-98	113,750
1998-99	113,850
1999-2000	125,000
2000-2001	135,000

Table 93: Trends in the increase of fishing boats in the coastal areas.

Year	No. of Fishing boats
1991	15,810
1992	16,336
1993	16,714
1994	17,919
1995	18,238
1996	18,770
1997	19,651
1998	20,189

D- Use of harmful fishing methods:

Use of some harmful exotic gears began in the 1970s in coastal areas of Sindh. Two types of these gears, *i.e.* encircling net 'Katra' and estuarine set bag net 'Bulo' are considered extremely harmful to juvenile populations of commercially important species which abound in creek systems. A trawl shrimp net 'Gujja' is also used in creek areas. These illegal gears have devastating effects on the local fauna and populations of commercially important species. Ineffective legislation and a lack of monitoring and surveillance facilities have resulted in a failure to prevent the spread of some of these fishing gears to the coast of Pakistan.

Harmful nets are increasingly depleting the fish resources

E- Absence of Jetty:

Keti Bundar is one of the key sites where marine fishing is very active and most of the local population is dependent on it. According to an estimate, there are about 3000 small and large boats which are engaged in fishing business. Unfortunately, there is no jetty where fishing boat can off-load safely. There is increasing demand for a proper jetty at Keti Bundar.

F- Inadequacies in Fisheries Data:

Fisheries data in the Keti Bunder like other parts of Pakistan faces the problems of inadequacy, reliability and accuracy. In most cases, fisheries data are based merely on estimates and personal judgments. Inadequacies in the statistical fisheries and aquaculture data collection system make the management of aquaculture and inland and marine fisheries resources, very difficult.

G- Environmental degradation:

Excessive pollution from Industries and agriculture is proving disastrous for the environmental life of this environmentally precious region. According to reports more than 2500 cusecs of Left Bank Outfall Drain (LBOD) effluent comprising poisonous pesticides residues are thrown in the Indus delta daily. Besides about 300 million gallons, urban sewerage from urban areas and about 37,000 tons of industrial waste are drained into coastal waters. This pollution is affecting marine life and ecosystem very badly. Fishing grounds coastal areas have been badly affected by industrial and urban pollution.

H- Lack of infrastructure:

Lack of suitable infrastructure is one of the key constraints to the development of the fisheries and aquaculture sectors of the country. In the context of capture marine fisheries, no landing facilities are available at major fishing centres, such as Keti Bunder. Other infrastructure facilities such as communication, educational and medical facilities still lack in Keti Bunder area. Problems faced for the transformation of products from aquaculture are similar. Lack of proper freezing facilities is another obstacle in increasing the shelf-life of fish.

I- Post-harvest losses:

Post-harvest loss owing to poor handling practices and a lack of preservation facilities on board fishing vessels and at landing centres, is some of the most important factors which result in the poor quality of raw material for processing and consumption. It is estimated that about 70 % of the harvested seafood becomes degraded or even putrefied before it reaches consumers or processing facilities. Opportunities to produce fish meal are missed as almost all by catch from trawl fisheries is left to decompose. A similar situation prevails in the pre-processing industry where shrimps are peeled under extreme unhygienic conditions.

J- Deep sea Trawlers:

In 1995 Govt. of Pakistan announced a deep sea fishing policy. Under this policy licenses for deep sea fishing are issued to deep sea trawlers of the international companies.

- The deep sea trawlers in the process of fishing catch a large number of unwanted fish and then throw it in the sea. This practice pollutes the sea water and the live fish leaves that area.
- These trawlers mostly use indiscriminate gear to have a maximum catch but only keeps that fish which generates lot of money. The official figure confirms that these trawlers discarded 332,000 m tons of fish during few years which resulted in a loss of 8 billion US$ to the country on one hand while on the other hand greatly polluted the water in the coastal areas.

- These trawlers are supposed to fish in EEZ some 32 km from the shore. They often violate the boundaries and practice fishing inside 35 km area and even close to creeks. Consequently, they not only deprive the fishermen from their livelihood but also damage their boats and nets.
- Being fully computerized and mechanized, these trawlers continue fishing un-abated and catch millions of tons of fish day and night. This over-fishing practice results in depletion of stocks of various fish species.

4.1.2 Threats to Aquatic Mammals:

- **Disturbance in Food chain:** The impact on the ecosystem is felt by the removal of the components of food chain. This may presumably be one of the factors of decline in population of aquatic mammals. Marine dolphins and porpoise are predators and hunt for their food. They feed on fish preferably sardines, squids (cephalopods) and crustaceans. They consume food equivalent to about 5% of their body weight. The dolphins being on the top of the food chain and the food they consume in turn feed on zooplankton and phytoplankton. Pollution by agricultural and domestic wastes, oil spill from the motorized boats is one of the factors affecting the food chain. Further, the overexploitation of fish by fishers is felt to be another factor that might not be full filling the feeding requirements of cetaceans in this habitat.

- **Habitat degradation:** Excessive pollution in the creek system results in less availability of food as well as habitat degradation. The creek system receives untreated upland runoff, coastal dumps and domestic sewage, which is drained here. Marine trash mostly consists of synthetic materials resistant to degradation in marine environment. The oil and oil dispersants from the boats are also source of polluting water. This is being unhealthy environment for marine cetacean.

- **Entanglement in fishing gear, accidental capture (by-catch), motor boat strikes:** Although commercial fishing is one of the most significant issues affecting cetaceans in most part of the world today and this affect is visible in Keti Bunder too. The dolphins and porpoise are directly injured or killed when entangled in fishing gears. The fishers do not try to rescue the dolphin when found entangled in their fishing net rather kill them. They are often knocked down by the motorized boats, causing injury to the animal as revealed from the discussions with local fishers.

- **Noise Pollution:** Man-made noise in sea is increasing due to increasing human activity which is harmful to cetaceans. It may cause hearing impairment, masking, behavioral or psychological disturbance in animals. Masking reduces the detect ability of acoustic signals which are vital for feeding, breeding, navigation, migration or other social actions.

- **Algal blooms:** Harmful algal blooms are natural phenomenon in which sudden growth of micro algae takes place affecting a wide variety of marine biota. Harmful algae species produce bio-toxins that cause mortalities in marine mammals.

4.1.3 Threats to Avifauna

Site specific impacts and threats are in no means complete but simply observations made during the survey. It seems that the major hurdle in the protection of avifauna and their habitat is the reconciliation of short term or long term interest of fauna and flora. With the increased growth of human population in and around the sanctuaries the progressive disappearance of the fauna and flora and degradation of the wetland increases. Shooting and trapping of birds have been reported but not observed.

4.2 KINJHAR LAKE

I. Scarcity of freshwater:

As mentioned earlier, both quality and quantity of freshwater in the lake is decreasing slowly, might be due to construction of the link canal at eastern side of the lake, diverting water away from the lake. Such a shortage of freshwater in the lake will obviously affect the mangrove forest and associated wetland ecology of the lake. Moreover, the ever increasing soil erosion upstream Indus River, resulting in excessive deposition of silt into the lake is another cause of water scarcity in the lake.

II. Water contamination:

Water carrying effluents from the tanneries at Hyderabad is continuously being drained into the lake for last ten years. It is not only deteriorating the quality of water, but also posing serious threats to the precious biota of the freshwater lake. A lot of poultry farms and livestock farms also exist on eastern side of the lake that are also a major source of pollution. The picnickers also frequently wash their vehicles in the lake.

There are many sources of pollution in the Kinjhar Lake. One of the causes of fish shortage in Kinjhar Lake is the material expelled by the industrial areas of Kotri and Nooriabad. Local industries of Kotri dispose off their wastes in Kalri Baghar (K.B.) Feeder which is the feeding source of Kinjhar, Moreover; growth of Australian un-rooted parasitical plant is another source of pollution affecting the growth of fish. Most of the cities and towns of Punjab and Sindh discharge their municipal and industrial wastewater into the Indus River. Another major problem in Kinjhar Lake is the eutrophication. The lake water is being enriched with nutrients, causing abnormal plant growth. Runoff of chemical fertilizer from cultivated fields may trigger this phenomenon. Use of this lake as a tourist spot is another source of pollution. More than 15000 people of Karachi visit this lake weekly. These tourists not only throw garbage into Kinjhar but also bring communicable human diseases to the local people and aquatic system by bathing/swimming in the lake.

III Logging and deforestation:

Heavy logging and deforestation on the eastern bank of the lake by local people mostly for fuel wood, fodder and agriculture are adding more silt to the lake besides affecting the highly specific fresh water ecosystem and its associated life, particularly the fish resource.

IV Illegal hunting & shooting:

Illegal hunting and shooting of the resident and migratory birds by locals as well as visitors mostly for meat, feathers and fun in the lake has been a continuous practice, disrupting the web of life and destroying the prevailing ecosystem indeed.

V Lack of education and awareness:

Lack of education and awareness could be the only one major threat to Kinjhar Lake and its biodiversity. Because, people being illiterate and ignorant about its ecological significance, are degrading the freshwater ecosystem and its biodiversity.

VI Multiple ownership of the Lake:

At present five Government Departments are performing different functions at the lake, which are Sindh tourism departments, Irrigation department, Wildlife department, Fisheries department and the Local government. The tourism department promotes the tourism activities, irrigation department looks after the embankments, link canal, and water quantity in the lake. The wildlife department takes care of the wildlife and fisheries department takes care of the fishing activities. The local government influences the auction of fishing rights in the lake. All these departments are working independently without consulting to each other and without considering the interests of the other departments. Activity of one department is often the problem for the other as tourism can be problem for wildlife species and fishing activities. It is important to reconsider this arrangement and a **Kinjher lake Development Authority** be established so that all the activities could be performed in a coherent manner.

VII Fisheries problems:

The lake, although managed by the Fisheries department and to some extent by local fisherman, still has the following alarming threats:

A. Lack of ownership:

Sindh Fisheries department being custodian of the lake is responsible for its care, conservation and management but unfortunately for the last few years, it has not been giving adequate attention towards it management, probably for the reason that they lost their interest in, when the government restricted issuance of fishing contracts and auctions in favour of the local fishermen. Now, due to inadequate care and poor management, the lake, it has been depleting gradually.

B. Reduction in Fish Landings

Due to a number of factors, the fish production in the Kinjher Lake has substantially reduced and the number of fishermen and the fishing boats have been reduced over the last 20 years. The following table provides an estimate of this trend:

Table 94: Trend in Fish Landings

Year	No. of Fishermen	Fish production (mt. tons)	No. of Boats
1988-89	24,355	58,000	2,200
1998-99	11,900	27,000	1,710
2005-06	10,320	15,650	820

The causes of this large scale migration of fishermen communities from the lake are the shortage of fish production in the lake due to continuous shortage of water in Kotri downstream, pollution of the lake with the growth of parasitical plants and causing deoxygenating of the water and affecting the growth of fish, non installation of iron nets on the faces of canals running out of the lake causing the outflow of fish seed form the lake, mismanagement in the process of releasing the fish seed in the Lake by fisheries department, absence of substitute income generating activities for the fishermen communities and non provision of education, health and infrastructure facilities.

C. Decreasing Fish Stock:

Unfortunately, no fish seed or fingerlings could be added to the lake, and hence the existing fish stock is decreasing rapidly. Four commercially important fish species, locally known as Rohu or Dambo, Dhai, Catla or Thalia and Morakha have been alarmingly declining for the last few years. Less catches of these highly priced fish species have ultimately reduced the dependant community's earning, adversely affecting the overall economic outlook of the area.

D. Alien Species:

Due to introduction of alien species like *Tilapia spp*. native bed reeds vegetation in the shallow western and northern waters of the lake has been disappearing gradually, which may affect the originality of the prevailing ecosystem in the long run.

E. Lack of market:

One other and may be one of the most important factors causing excessive exploitation of fish resources is lack of appropriate market for selling the catch on daily basis. Local fishermen, having no options other than to sell their catch to the local middlemen against the money they lend from them or having no access to the market where they could get appropriate return for their catch. Ultimately, to earn a few more pennies, they try to catch more and more, gradually making the lake dead for fishless.

F. Construction of Link Canal

Historically, the Kinjhar Lake was receiving water from the main river Indus by the K B feeder canal. It was bringing turbid water of the Indus to the lake. To avoid this turbidity to be mixed in the lake, a link canal was constructed to divert the water directly to the canal feeding Karachi bypassing the Kinjhar Lake during monsoon months. The K. B. canal was a seed bank for the commercial fishes in the Kinjhar Lake. It was bringing millions of fingerlings and fries of the fish that were breeding in the main river Indus each year and the lake was replenished by the new stocks of fish seed. By construction of Link canal the Kinjhar Lake is not stocked by this natural fish seed and the fish production in the lake is severely affected.

G. Over fishing due to Auction System/ License System:

A major cause of decrease in the inland fisheries is the auction system under which Govt. has auctioned the fishing rights of the lake to the local people or the influential contractors. In Kinjhar lake area there is license system. Both these systems are highly controversial. The contractors as well as people having License, both take it for granted to get as much catch as possible to have maximum profit. They do not bother about any rule or regulation. Any means of fishing, whether legal or illegal, is being adapted and any size of fish is being caught. The Kinjhar Lake is the worst example of overexploitation of fisheries resource in the country. If this situation continuous, there will be no fish in the years to come and more and more fishermen will be left jobless.

H. Conflicts with Fishermen Community and Fisheries Department

There is a conflict between local fishermen and fisheries department regarding the auction system or the license system. Consequently fisheries department is not putting required quantity of fish seed in the lake which is urgently required at the moment as the fish stock is depleted and there is no natural recruitment through K. B. Branch. The lake requires 2,500,000 mixed fish seed annually to meet the present fishing pressure.

I. Escape of fish seed from the Lake

The lake has an open outlet in the form of the canal supplying water to the city of Karachi. Most part of the fish seed that is put in the lake by the fisheries department is escaped from the lake through this canal. As the lake is not being naturally recruited and a major part of the seed stocked by the fisheries department is also escaped, then where from the fish will come in the lake and it will definitely result into a situation which is presently being faced by the fishermen community in the Kinjhar Lake.

4.3. CHOTIARI RESERVOIR

Chotiari reservoir has a lot more importance for people inhabiting in and around the reservoir. Local communities use lake waters for drinking, livestock and irrigation. The large lakes within the reservoir area are contracted for fish harvesting by the Fisheries Department annually. The local economy of the area relies largely on agriculture, livestock and fishing. By virtue of being located at the edge of desert the poverty among the local communities is more common and the resource degradation is more rampant. Chotiari reservoir is facing a number of threats which are summarized below:

I. Lack of social services

The social problems faced by the area includes lack of safe drinking water, lack of education, lack of health facilities, unemployment and dominance of influential local interest groups.

II. Hunting & Shooting

As the wetland is unprotected, hunting of wildlife is common. Hunting causes a great deal of disturbance to water birds which causes them to shift to other areas. The population of Hog deer and other important wildlife species have also been affected due to hunting. Community lacks sources of income generation to improve their livelihood.

III. Fisheries Problems

Chotiari reservoir is an area which has the least problems regarding pollution, over fishing, introduction of exotic species, etc. It, however, has other problems that are not met in other lakes of the coastal areas. Some of these problems are:

A. Unsustainable fishing practices

The use of unsustainable fishing practices by the fishing contractors is undermining long-term sustainability of fisheries in these lakes. These include, use of small size fishing nets, use of poison and chemicals and over fishing. Degradation of fisheries poses a potential threat to the livelihood of local fishing communities. The shortage of freshwater is also affecting the hydrological regimes of different lakes in the area.

B. Eutrophication of Reservoir:
Chotiari reservoir falls in tropical areas with very hot summers. The water temperature reaches to 33º C during the summer months. The lakes are full of vegetation. As dead and dry part of this vegetation decays during the hot summer months and releases extra nutrients in the lake which in turn cause the growth of more and more vegetation and algal blooms. Both these phenomena cause eutrophication on one hand and cause a sudden deficiency in the dissolved oxygen which can be fatal for many fish species. This situation is more dangerous during night when there is no photosynthetic activity and the dissolved oxygen is taken up by the decaying organic matter and the phytoplankton.

C. Lack of Hatching Facility on the reservoir:
All the lakes in the Chotiari reservoir area are regularly auctioned. During flood years substantial fish seed is received by these lakes from the river through flood water but when there are no floods for many consecutive years, the fish stocks in the lakes get depleted. For sustainable fisheries exploitation, a network of hatcheries must be established on different points of the reservoir so that the lakes are continuously recruited by the fishes of commercial importance. This will result in an increase in the income of fishermen on one hand and in the Govt. exchequer on the other as the lakes will be auctioned at a higher rate.

4.4 PAI FOREST

Pai forest being the only irrigated plantation in the area and surrounded by almost more than 20 villages of varying sizes, is faced with a number of problems and threats. Some of the principal threats are summarised below.

i. Shortage of Water:

Dry look of tees clearly show symptoms of water shortage

Pai Forest has a sanctioned water of 30 cusecs which is sufficient for irrigating 1,212 ha of plantation. But out of sanctioned water, only about 10 cusec of water is generally received because the plantation is located at the tail end of the irrigation channel. In order to overcome this problem, 13 tube wells have been installed inside the plantation at different times to irrigate the tree plantations. The prevalent practices of irrigation are very defective. Presently, the plantation doe supplies and only regeneration areas and young crops wells. Due to shortage of irrigation water, the plants are of low quality and give a dry look.

ii. Illegal wood cutting:
Currently, this plantation is in miserable condition mainly due to uncontrolled massive wood cutting. Most of Kandi *(Prosopis cineraria)* have severally been lopped and removed.

Illegal wood cutting by local communities goes on unchecked

iii. Exotics & Invasive Species

Pai forest has 6% area under Eucalyptus trees which are highly water demanding on one side and also transpire huge amount of water thus creating more stressful conditions for nearby trees. Moreover, Mesquite (*Prosopis juliflora*) is present every where in the plantation and some areas have been infested severely. This species is an aggressive competitor and can out-place the local flora.

iv. Livestock Grazing:

Yearlong intensive grazing mostly by goats is widely present in the Pai forest. Since goats are browsers hence these animals harm the young seedlings while trampling the soil that impedes further regeneration.

Livestock grazing is also widespread in Pai Forest

v. Encroachments:

Land of Pai forest, particularly on northern fringe has been encroaching by neighbouring farmers and this area is brought under agriculture. There are a number of cases under trial in the courts. Such encroachments not only weaken the writ of Forest Department but also encourage the others to adopt similar illegal approach. The extent of encroachment could be well-visualised by the nearby Mari Riverine forest where most of the state-owned area has been grabbed by the encroachers.

vi. Poor quality of habitat:

Hog deer are reported in Pai Forest. By looking at the monoculture of core area, one wonders how it could be called a Hog deer habitat. This area not only lacks any natural herbaceous flora on which Hog deer can survive but also does not have water. The animals use this area for refuge purposes and hence go outside in private agricultural areas to meet their feed requirements. Frequent movement of Hog deer to outside area makes them more vulnerable to external threats. Last year, two Hog deer were found killed on National Highway. Under such stressful conditions reproduction of animals is also affected severally.

vii. Threats to Hog deer

1. *Hunting with dogs in the forest*. The local influential people are fond of keeping dogs which are used for hunting wild boar and hog deer. During the present study, evidences were collected when hunting dogs caused deadly injuries to hog deer. According to locals, this is an easy way to hunt Hog deer.
2. *Trapping of the Hog deer*, when it crosses the boundaries of the forest due to absence of fence. Sometimes, it runs over the highway and get accidentally killed. One such evidence is also recorded.
3. *Habitat destruction inside the forest*. Besides other factors, the hunting areas are being increased by cutting forest areas and starting cultivation in those areas. The cultivated areas are basically partridge hunting sites.
4. *Dryness of the forest* due to lack of water in most parts of the forest, as the existing tube wells are used for irrigating cotton, wheat and mustard crops inside the forest. The crops are cultivated for increasing food availability and shelter for partridges for which shooting permits are issued.
5. *Regular practice of cutting the trees* in different compartments of the forest. Aridity in the area is also increasing due to plantation of fast growing *Eucalyptus* tree in the degraded areas.
6. *The Predation* of fawns by Jungle cats and Jackals. It is being a natural threat in the ecosystem.

Table 95: Merits and Demerits of Pai Forest for Being Candidate Site for IFAP

S. No.	Demerits	Merits
1	Pai forest does not represent natural Riverine ecosystem rather It is an irrigated plantation.	It is the only abode of Hog deer left so far in lower Indus.
2.	It has a number of exotic plant species such as Eucalyptus and Mesquite (*Prosopis juliflora*)	It is the only intact plantation in comparatively stable state which also carries the title of Protected Area *i.e.,* Game Reserve
3	Core habitat of Hog deer is dominated by a single species (i.e., monoculture of *Prosopis cineraria).*	Forest Department outwardly shows interest to include this in IFAP for its long term maintenance and conservation.
4	There is no food and water available for Hog deer inside plantation. Hog deer use Pai forest as a refuge site and forced to go outside in farmlands for feeding. Hence Hog deer are more vulnerable to threats.	Being situated along National highway and in vicinity to Sakrand, this plantation has tremendous potential for eco-tourism.

5	Enormous disturbance by surrounding population on Pai forest for wood and grazing needs.	Through well-conceived conservation & demonstration, the site has good potential for environmental education and awareness.
6	Encroachment of land by surrounding influential farmers is a growing threat	IFAP, through its interventions, can re-vitalise the interests of Forest and Wildlife Departments for future conservation initiatives.
7	There is severe water stress for plantation. Tube well water is used for raising agricultural crops to feed Hog deer and attract partridges.	It is the only site out of four selected for IFAP where Forest Department has a direct stake. Thus selection of this site would bring Forest Department closer to conservation agenda not only on this site but elsewhere, as well.
8	Wildlife & Forest Departments staff is highly unskilled and poorly equipped.	Taking up conservation measures at this site will give a strong message to land grabbers and other stakeholders about the writ of Forest Department over state areas.
9	Inconsistency of financial allocation to maintain plantation and wildlife population in healthy stage.	Conservation and up-scaling of biodiversity activities over this site will develop much closer relations between Forest & Wildlife disciplines.
10	Forest Department has commercial interest in plantation to earn revenue.	Community members could potentially be involved in income generating activities such as eco-tourist guides, fee earned through gate money etc.
11	Surrounding communities have limited opportunities to be involved directly in conservation efforts inside Pai Forest.	Partcipaory NRM could be tested over here by raising woodlots in vicinity of Pai Forest.
12	In spite of the fact that neighbouring communities illegally cut the trees for fuel wood and graze their animals, inclusion of Pai Forest in IFAP will deprive these communities from such benefits in case no alternatives are provided.	By involving local body institutions, possibilities could be explored for provision of natural gas or LPG to relatively large villages

SECTION 5

RECOMMENDATIONS

RECOMMENDATIONS:

The recommendations are indeed based on preliminary findings and are not intended as final and conclusive pronouncements. It is expected that further research will enable the Indus for All Team to develop a set of realistic recommendations based on detailed investigations.

5.1 KETI BUNDER

1. The foremost step is to organise communities through rigorous social organisation. The focus groups should be the people living inside creeks where most of the mangrove forests exist and fishing is practiced.
2. Hajamro creek has enormous potential of raising mangroves and supplementing the existing mangroves which are still in juvenile stage. Similar efforts could be done to other creeks.
3. Chann creek has good mangrove forests; however, these are under severe threat of camel grazing and wood cutting. With the collaboration of Sindh Forest Department, alternatives should be explored to abandon this area from camels and enforcement of strict measures for commercial harvesting of mangroves.
4. Keti Bundar has other serious problems that include fresh water supply, health, education and Solid waste management issues. All these issues could be addressed once a Community Organisation is in place. Coordination with local body institutions is yet another frontier that needs immediate attention.
5. Ensure that aquaculture is closely linked to plans for investment in irrigation, irrigated agriculture and related infrastructures.
6. Establish a joint Committee composed of representatives of all Ministries dealing directly and indirectly with freshwater use.
7. Jointly engage in discussions and planning with other Ministries on priority uses, protection, sustainable development and increased productivity of freshwater resources.
8. Establish strong collaborative partnerships and processes to increase water flows in Indus River and tributaries and re-establish balanced water regimes/use.
9. Monitor the impact of water diversions on habitats and livelihoods, and develop guidelines for the mitigation of negative impacts.
10. Support literacy, vocational trainings and other educational programs in fishing communities.
11. Support alternatives and/or complementary livelihood activities in fishing communities through increasing access to credit and savings schemes and the provision of micro-finance initiatives.
12. Promote the participation of women and benefits from their involvement, in aquaculture, post-harvest and other livelihood activities.
13. Advocate for the allocation of marginal land for agricultural use to fishing communities who are affected by water diversion/limited release of water in the River Indus.
14. Formulate and implement an integrated coastal zone management plan.
15. The following recommendations are made with regard to fisheries sector:
    - There is a need to develop a Jetty for the fishermen at Keti Bunder to facilitate them to off-load their catch safely. For this matter, a committee of all the

stakeholders should be formed to advise to launch this facility without further delay.

- Establish guidelines and promote the use of environmentally responsible fishing practices (following internationally-established codes and standards).
- Control fleet size and fishing capacity.
- Create an exclusion zone for deep sea trawlers in coastal waters.
- Implement a seasonal ban on catching shrimp in coastal areas during the months of May, June and July.
- Conduct resource surveys, species stock assessments in marine (coastal and off-shore) waters.
- Determine and regulate optimal harvesting levels in marine waters.
- Initiate a programme of awareness raising targeted at fishing communities and the general population about fish bio-diversity, natural fisheries environments, sustainable resource exploitation and conservation.
- Establish a system of regular monitoring of various habitats along the coastline, including mangroves, marine turtles and other aquatic biodiversity.
- Creation of alternate means of livelihood
- Initiation of thorough surveys regarding fisheries resources and deciding the maximum number of fishing boats
- Create awareness among the masses and fisher folk regarding the consequences of overexploitation of fisheries resources.
- Ensure the enforcement of fisheries laws and frame new set of fisheries laws ensuring sustainable fisheries in the coastal areas
- To formulate a committee among the local fishermen to check the boats for illegal fishing gears.
- Impose heavy fines on the use of illegal fishing nets and confiscation of illegal fishing gears.
- Establish guidelines and promote the use of environmentally responsible fishing practices (following internationally-established codes and standards).
- Educate local fisheries community about the long term damage caused by the illegal fishing practices.
- Implement a comprehensive and harmonized data collection system across provinces coordinated by Fisheries Departments at provincial level, with reporting to the Federal Bureau of Statistics.
- Maintain yearly statistics of individual species of commercial importance.
- Contribute to the establishment of guidelines and processes for providing compensation to those affected by pollution based on the polluters pay principle.
- Ensure that industrial waste and domestic sewage is treated prior to release into marine environments.
- Assess, mitigate and control environmental degradation and pollution on coastal habitats.
- Enforce pollution control legislation in coastal areas.
- Create auction centres and markets for marine fish products, at major fishing harbors.
- Build landing facilities along the coast and construct landing jetties at major inland fish landing areas and at other major freshwater fish producing water bodies.
- Establish pre-processing industries (peeling sheds) in at the fishing centres.
- Improve transportation of aquatic products.
- Construct and improve road links from harbors and landing centres to the

urban centres.

- Improve access of aquatic products to international markets.
- Address comprehensively quality issues and establish quality assurance programmes.
- Assist in installation of quality ice making machines on board of fishing vessels and refrigeration systems on board of fishing boats involved in longer fishing operations.
- Install quality ice making plants and cold storage facilities at all major fish harbors.
- Create/improve quality control in the landing centres, including promoting the use of fish crates and insulated boxes.
- Attract private investment in building and expansion of storage facilities at inland/coastal landing centers and near market centers.
- Add value (transformation/processing) to aquatic products.
- Improve by-catch utilization.
- Promote the establishment of private value-adding processing facilities.
- Establish demonstration facilities for value addition and improved processing
- Improve transportation of aquatic products.
- Promote the use of insulated boxes and refrigerated carriers through provision of soft loans.
- Improve hygiene conditions in all fish markets.
- The companies found responsible for throwing trash fish in the sea must be heavily fined.
- The trash fish must be purchased at low rate if inevitable and then re-sell in local market or utilized for preparation of fish meal.

16. Collect information on the pelagic ecosystem around Keti Bunder and how this affects the marine cetacean population.
17. Conduct regular surveys for at least a period of two years of small cetaceans (dolphins and porpoise) in creeks recording their abundance, seasonal distribution pattern and habitat use.
18. Capacity building of fishers in cetacean identification, conservation and management.
19. Launch education and awareness programme on marine cetacean conservation so as to minimize the anthropogenic threats to the species and habitat.
20. Initiating dolphin watch or ecotourism programme involving local communities and building the capacity of local community for organizing dolphin watch. This would provide incentive to the local community as an income generating activity and ultimately they would safeguard species and habitat. This would promote community based sustainable management of the species and habitat.
21. Installation of billboard at entrance point of Keti Bunder with information on marine cetaceans for public awareness.
22. Awareness raising outreach programmes for locals should be initiated to get them understand of the importance of wildlife including mammals.

5.2 KINJHAR LAKE

Although problems are numerous and require holistic approach for their remedial measures, yet these require prioritization for setting the direction to overcome within limited time frame. One should realize that there are three main areas for which Kinjhar lake is potentially utilized; Fisheries, tourism and drinking water. Apart from the resources discussed earlier, surrounding communities also earn their livelihood through livestock rearing. Most of these livestock are dependent on the pastures situated on the verge of this lake. Following section will cover briefly the interventions needed to these four major areas of concern.

Fisheries Resource:

- Since the day of banning auction of fisheries at Kinjhar, provincial Fisheries Department has almost lost its interest for the upkeep of this vital resource. No fingerlings or fish seed have been put in the lake to sustain the resource. In the absence of such intervention, fish stock in the lake has considerably reduced. There is dire need to involve Provincial Fisheries Department and the local fishermen communities to take up this important aspect on urgent grounds.

- There is an immediate need to put nets on in and outside to prevent the escape of fish seeds and juveniles fish into the canal.

- Fishermen communities are very poor and cannot get good quality fishing gear. They are still using age old methods. It would be advisable if they are provided credit facilities to buy improved fishing gears to increase their means of livelihood.

- Introduction of exotic fish species like *Tilapia* should be discouraged in future.

Tourism:

- Because its vicinity to Thatta and Karachi, Kinjhar lake is frequently visited by large number of tourists year-round. There is serious need to provide quality facilities for the incoming tourists according to their age profile. This requires setting up a Visitors Centre containing good quality souvenirs and, brochures. Visitor's Centre should also get the feedback from the tourists about facilities they require for enhancing the quality of the tourist facilities.

- In the past some fatal accidents have occurred in the lake due to poor quality boats and increased load on such boats. Sindh Tourism Development Corporation (STDC) should take a lead to ensure the safety of tourists by strict law and order enforcement. Boatmen should not allow visitors on their boats beyond permissible limit. Moreover, STDC should also arrange small credit facilities for purchase of speed boats, life jackets and other paraphernalia required for water support. All the boats used for tourists should be properly registered and regularly visited by STDC to ensure safety measures.

- Currently, the lake water is used for washing commercial and domestic vehicles which not only add contamination to the water but also invite different hazards. Kinjhar Lake is used for providing drinking water to Karachi city and the surrounding communities and houses rich aquatic life. Oil coming out of vehicles can severely damage both human as well as other aquatic life.

- Presently, STDC has a nice facility of boarding and lodging for tourists at the lake. However, this facility is deteriorating due to negligence on the part of senior officials. The quality of beds, wash rooms and furniture is absolutely unbearable. Probably, senior officials either do not visit these cottages or they are well taken care off by the keepers and hence do not bother about the tourists.

Water:

- As mentioned in the preceding paragraphs, Kinjhar is an important source of drinking water for the people of Karachi and neighbouring villages. Moreover, it is also important abode for a variety of fishes on which livelihood of a large population of fishermen communities is dependent. Being Ramsar site and a Wildlife Sanctuary, the waters of this lake are important for harbouring thousands of migratory waterfowls during winter. For the care of such important aspects, it becomes increasingly important that both quality and quantity of water should regularly be monitored. To ensure that such monitoring is in place, now and in future, an Executive Body comprising senior members from all concerned government departments, non-government agencies, local body institutions and the local communities should be notified by the provincial government. This body should be vested with certain legal and regulatory powers for taking corrective measure without seeking permission from elsewhere.

- Effluents from the agricultural fields and tanneries should be controlled and stopped immediately. Ban on washing vehicles in lake water and other sources of contaminants should be taken immediately.

- There are a number of poultry farms and livestock farms on the bank of Kinjhar Lake on eastern side. These farms are not only a regular source of contamination of lake water but also increasing eutrophication in the water body which is severely hampering the aquatic life and encouraging weeds to occupy water body.

Pastures & Livestock:

- Peripheral areas of Kinjhar Lake are used as grazing grounds for the livestock of neighbouring villages. These livestock include small and large ruminants. Overgrazing of surrounding pastures trigger soil erosion thus silting of water body. Animal dung is also a source of contamination. To regulate such grazing, there is a need that local population is provided inputs for raising improved fodder crops on agricultural fields.

- Neighbouring grounds are also infested with Mesquite (*Prosopis juliflora*) and other exotic plants such as *Eucalyptus* sp. Mesquite itself is a big threat to the local ecosystem as it is out competing the local flora and bringing disruption in the local ecosystem. There is a serious need to check such alien species on regular grounds.

  With the growth of Australian parasitical plant and other useless grasses water is deoxygenated causing great loss to the aquaculture and fish growth and health.

- Islands inside lake possess pristine flora that provides unique opportunity to the researchers and students for studying plant wealth of this region. These islands should immediately be protected from wood cutting and other intervention that may alter the plant composition.

- There is a unique inland stand of *Avicennia marina* present in close vicinity of Kinjhar Lake that needs protection through fencing.

- **Direct flow of the Canal into Lake**

The link canal should be separated from the lake and in the breeding season. Water from the main Indus river be directly released into the lake. Plenty of healthy natural fish seed is present in the river water and suitable to grow easily than the artificial seed.

- **Prevent lake from industrial Waste:**

To prevent the lake from the pollution and supplying the pure drinking water to Karachi, it is necessary to prevent lake from the toxic material of Kotri and Nooiabad Industrial area. If the toxic material released by these industrial areas keeps on continuously mixing with the water of Kinjhar lake, it can cause great harm to the human population on one hand and the aquaculture and the live stock on the other.

- **Establishing fish nurseries on the banks of Lake:**

It is necessary to build the fish nurseries on the banks of lake and annually five million fish seed must be released into the lake because many fish species have almost become extinct. Fishermen communities do not find the fish species even for eating purposes which in past was regularly exported to England, Kuwait, Saudi Arabia and other countries. It is necessary that the fish nurseries be established on the banks of the lake to release a substantial quantity of fish seeds every year in the lake so that a sustainable exploitation of the resource could be made possible.

- **Installation of iron nets at the outlet**

Installation of iron nets are important on the outgoing canals to stop draining of fish seed and fingerlings from the lake.

- **Awareness through community**

An awareness about the wise use of fish resources, consequences of overexploitation of fisheries resources, use of illegal fishing gears, fishing in breeding season and rehabilitation of lake needs to be started through the mosques, community based organizations, fisher folk organization and through the local governments.

- **Ecotourism**

Kinjhar is the best area for introducing the ecotourism. The watch towers at potential points and other facilities need to be developed. The local community should be involved and benefited from this activity. They could be trained to conduct ecotours. This provides incentive to the local community as an income generating activity and an alternative livelihood source.

- **Outreach Programme**

An outreach programme should be initiated to provide environmental education to locals and general public highlighting the importance of this ecosystem and inhabiting wildlife.

- **Protection of wildlife habitat**

Efforts need to be taken so that the wilderness in the area particularly in the eastern side does not completely vanish. This would ensure that the habitat for carnivores is available.

The Wildlife Protection Ordinance should also be effectively implemented.

5.3 CHOTIARI RESERVOIR

Apart from the most important resources of fisheries, the Chotiari reservoir needs immediate attention for the following areas.

Natural Vegetation:

Chotiari reservoir is a unique landscape that contains water bodies and the desert ecosystem simultaneously. This merger of different ecosystems within the same area presents a wealth of flora and fauna. Although present study tried to record flora of different habitats yet it was a snap-shot activity. It is believed that there is ample opportunity that many plant species were left unrecorded and hence need long-term comprehensive study to document both terrestrial and aquatic flora. On completion of such detailed investigation, one can visualise the floral wealth in totality and thus ascertain the diversity of habitats which provide abode to different animal species. Surprisingly, Bhan *(Populous euphratica)* was seen growing inside Chotiari reservoir in spite of the fact that this species is found only in riverine belts. Apart from Nara region, Chotiari is the only place which provides last resort to many animal and bird species such as Hog deer, Crocodiles, Marbled teal and Otter. The extent and sensitivity of the food webs in this unique landscape essentially demands much detailed floral investigation.

Pastures & Livestock:

The preliminary study revealed that local communities depend heavily on livestock rearing for their sustenance. Livestock includes both small and large ruminants of varying number. Livestock such as cows and buffaloes were seen grazing even on distantly located islands where such animals can only approach through transportation by boats. There is a large variety of grasses, forbs and shrubs that provide nutrient rich feed for all kinds of livestock. Carrying capacity of these grazing grounds needs to be investigated thoroughly and then vegetation maps could be developed accordingly.

Beautiful pasture exist in and around Chotiari reservoir to support small and large ruminants

Local communities in arid areas largely believe in more numbers of domestic animals than their quality. The reason for such attitude is largely attributed to the low cost associated with grazing and also to social instability. Until carrying capacity of important pastures is not determined, one cannot suggest the kind and number of livestock in a manner where competition among wild herbivores and domestic livestock for food is minimised.

Encroachment by Mesquite:

Likewise other areas of Sindh, Mesquite (*Prosopis juliflora*) is increasingly encroaching the landscape in Chotiari. If proper and timely measures are not taken, it will alter the ecosystem. Some areas at the water margins are even not possible to access due to profuse growth of mesquite.

Mesquite is invading almost every ecosystem in Sindh

Increased Wood Cutting:

Presently forests and rangelands in and around Chotiari do not carry any legal title. Forest Department is almost absent from this area. Consequently, people cut trees without any check. Tractor trolleys and donkey carts carrying wood are common scene at Chotiari. It was told that most of wood goes to Sanghar town for commercial purposes. Such heavy wood cutting if continues unchecked, there will be little refuge for the wild animals in the area.

Due to absence of Forest Department staff in Chotiari, wood cutting is widely prevalent

Wildlife Conservation:

Chotiari is famous for a variety of wild fauna that includes Hog deer, Crocodile, Otter and large number of migratory water fowls. It is used to be an important breeding ground of Marbled Teal, which has been affected with the construction of reservoir and needs investigation about its present status. Although Pir Pagharo (a well-known religious and political figure of Sindh) has a traditional sanctuary for Hog deer and partridges, yet hunting of water fowl is reported. Sighting of Crocodile and Otter is also not frequent. To conserve such unique species, participatory conservation efforts are required immediately.

Fisheries Conservation:

- Gradually clearing of the lakes from weeds and aquatic plants using dredges and other mechanical approaches.
- A net work of hatcheries be established at the reservoir to recruit the lakes for improving fish stocks for sustainable use of the fisheries resources
- Construction of cold storage for holding the fish for few days
- Involve the private sector for the establishment of cold storages and sale points so that local people could sell their catch at an appropriate rate
- The monopoly of the local influential contractors should be controlled through open auctions of the water bodies for fishing rights.
- The local fishermen may be granted loans at low interest so that they could purchase boats
- The local fishermen organization may be strengthened so that they could protect their rights.

Introduction of Hog Deer:

Hog deer may be reintroduced in the appropriate habitat which still exists in the area. Heavily vegetated banks and reed beds along side the lower Nara could be studied for its suitability for reintroduction. Community based management of the important wildlife species including Hog deer may be promoted. Incentives through controlled hunting could be provided to community, once sufficient population develops in the managed area.

Evidences suggest that once rural people appreciate the value of their wildlife and are able to benefit from it personally then they will conserve it in order to get benefit from it.

Incentives of controlled harvest should be allowed once sufficient population develops in the managed areas. Such a mechanism could be developed that encourage community to invest in the protection and management of Hog deer as well as other wildlife and its habitat.

Ecotourism:

Ecotourism is another potential activity that could be developed with the improvement in wildlife species. Trainings could be provided to locals for conducting ecotourism.

Implementation of Wildlife Act:

The implementation of Wildlife Protection Ordinance should be enforced. The capacity of local wildlife staff may be built in wildlife conservation and management. The adequate numbers of wildlife staff may be posted and they may be provided facilities for effective mobility.

5.4 PAI FOREST

1. Pai forest should be selected only for the reasons that (i) it provides abode to the only remaining population of Hog deer in lower Indus except Chotiari and (ii) it is the only intact and healthy plantation left so far in lower Indus.
2. Once it is decided to be included in IFAP, it must be fenced all around to exclude threats of encroachment, wood cutting, grazing and movement of Hog deer from Pai forest to neighbouring agricultural fields.
3. To address the fuel wood requirements of neighbouring communities other avenues must be explored such as initiation of dialogue with Sui Southern Gas to provide natural gas connection to at least big villages. Another option could be to raise fuel wood lots at the nearby Mari Riverine forest area which is totally devoid of trees and area has been leased out to farming community. Fuel wood lot on this area would be successful if local communities are involved in watch and ward, planting and after-care operations. A scheme of wood sharing after 6-year rotation could be worked out involving Nazims of concerned Union Councils and Forest Department.
4. Once fenced, suitable watering points for Hog deer and food sources in Pai forest will have to be developed. Openings inside wood thickets will also be required to develop in consultation with Wildlife and Forest Departments.
5. Two entrance gates, one at National Highway and other in the back side need to be developed and an entry fee for the visitors is recommended to generate some funds that could be re-utilised for the maintenance of facilities and quality of the plantation.
6. Exotic species such as Mesquite and *Eucalyptus* should be checked and controlled. Instead, local species such as Babul (*Acacia nilotica*), Khabbar (*Salvadora persica*), *Salvadora oleoides, Acacia senegal* etc. should be planted to add more diversity in the plantation. *Acacia senegal* plantation can be exploited for extraction of gum Arabic.

6. Plantation of some fruit trees near the tube wells, Guest House and Forest colony for the attraction of various birds and also for the visitors.

7. Incentive for wildlife watchers who conserve this endangered animal through their round the clock efforts.

8. The existing tube wells are being used only for cultivation purposes in beat areas. These should be used for irrigating forests only.

9. Cutting of trees in the forest is a common practice which create disturbance to Hog deer.

10. Shooting of partridges also disturbs the animals in the forest. Shooting should be banned and status of the forest as Game Reserve should be changed to a wildlife sanctuary for conserving Hog deer.

11. The abandoned enclosures constructed by the Sindh Wildlife Department for partridge and Hog deer breeding may be made functional. The abandoned tube wells in that compartment (No. 98) should be restored.

12. Erection of information sign boards at entrance and other important points, providing information about Wildlife Laws etc.

13. Ensure better coordination between Forest and Wildlife Departments.

14. Communities around the forest should be mobilized for biodiversity conservation and outreach program established for them.

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ANNEXURES

ANNEXURE

Annex 1

Table 1: Physico-Chemical Analysis of Soil of Study sites

Location	Transect No.	Parameters mg/kg					
		pH	Total Kjeldahl Nitrogen	PO_4-P	Organic Matter %	Potassium	Soil Texture
Q2	Keti Bunder	7.12	1250	8.14	26.60	352	Well sorted silt and clay
T7	Keti Bunder	7.11	465	12.00	23.94	273	Sandy

Analysis was carried out by Institute of Environmental Studies, University of Karachi.

Annex 2

CETACEAN SIGHTINGS RECORDING PROTOCOL
(Only for Keti Bunder)

Observer: ______ **Recorder:** ______

TIME START	TIME END	DISTANCE AWAY	LOCATION: Latitude	Longitude	BOAT SPEED	

INITIAL SIGHTING CUE	.NUMBER OF INDIVIDUALS	BEHAVIOUR
Dorsal fin Back Blow Fluke Splash Breach Fishing boats Birds Other	Minimum estimate - ____________ Maximum estimate - ____________ Best estimate - ____________ Associated Species & their Behaviour:	Feeding Travelling Surface active Singing Resting Milling Mating/Sexual/Aggressive Undetermined Other Average dive time (if recorded) _____________ minutes
SPECIES	**SIZE**	**APPEARANCE**
Family Genus Species	**Avg. (**adults**)** _________ **m** Min (**juveniles/ calves**) ___________m	

DIRECTION OF TRAVEL	**GROUP COMPOSITION**	**HUMAN ACTIVITY**
N أ Varied SE أ Undetermined S NE E SE S SW Cetacean Speed W _______ km/hr NW Speed estimated ____ or measured ____		Nets Traps Fishing boats Recreational boats Cargo vessels/Tankers Military vessels Seismic survey Whale-watching None Other

EFFORT LEVEL	**NOTES & DRAWINGS**
Sighted during: optimal effort sub-optimal effort off effort during another sighting	

ANNEX 3

FISHING COMMUNITY SURVEY

Date___________________ Locality_____________________________________

Name of fisher______________________________________ Age_____________

Full or part time fisher__________________ Size and type of boat_____________

Distance offshore or area he fishes______________________________________

- Does he know what dolphins are: fish, shark, mammal or else:

- How often sees dolphins
    - What time of year
    - Where

- Does he or villagers find any on the beach

- Do they cause any problems to fishers? What types of problems, if any?

- Do they capture dolphin? If yes, then for what purpose?

- What size group usually seen?
    - 1-3
    - 5-10
    - 50+
    - 100s

- Size of animal?
    - <1m
    - 1-2 m
    - 2-3 m
    - 3-5 m
    - >5 m

- What does he think, the population of dolphin is increasing or declining or stable.

- In his opinion, what is the threat to dolphins?

ANNEX 4 - RECORD OF TERRESTRIAL MAMMALIAN SPECIES DETECTED DURING THE SURVEY

APPENDIX – I

DATA SHEET — **LINE TRANSECT COUNTS** — Transect No.: p: of:

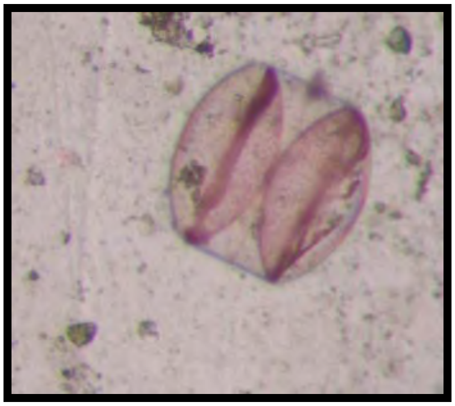
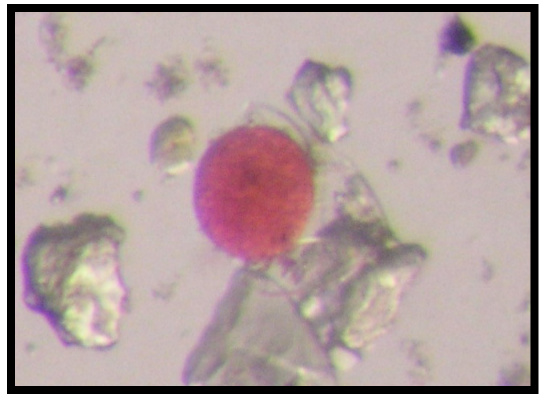
Locality:	ROUTE	Starting Point::
		Direction (magnetic): Total Distance (km):
Date:		Finishing Point::
Observer:	***Weather during Transect***	Temperature:
Recorder:	Cloud Cover:	Wind Direction:
Others:	Precipitation:	Wind Speed:

Section Number	Starting Time	Finishing Time	Duration (min)	Length (m)	Habitat Type	OBSERVATIONS *(see example below)*
3	*10:14*	*10:28*	*10*	*600*	*M*	*C2, C 1, U 3, U 12, I 16, I 8,*

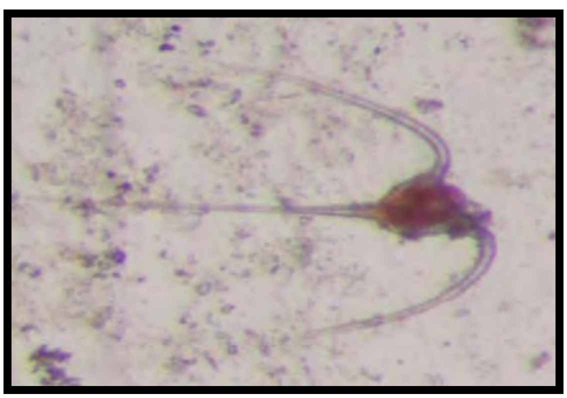
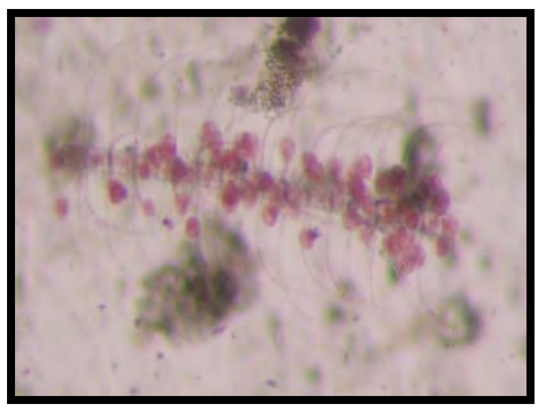
Annex 5

Pictures of Planktons and Macro fauna Observed at Keti Bunder

Some representative Phytoplankton

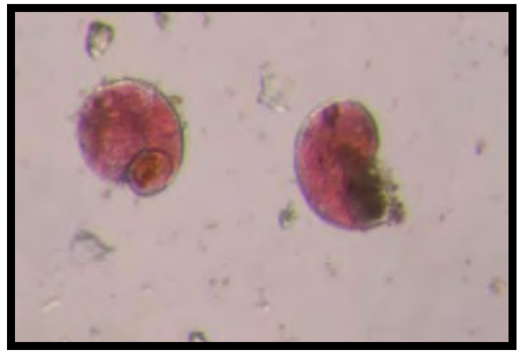
Diatoms

Ceratium sp.

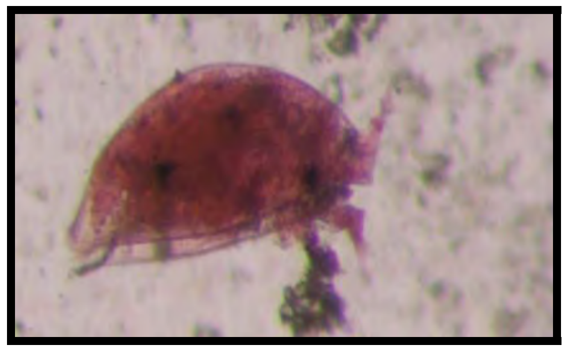
Picture : Some representative Zooplankton at Keti Bunder

Copepods



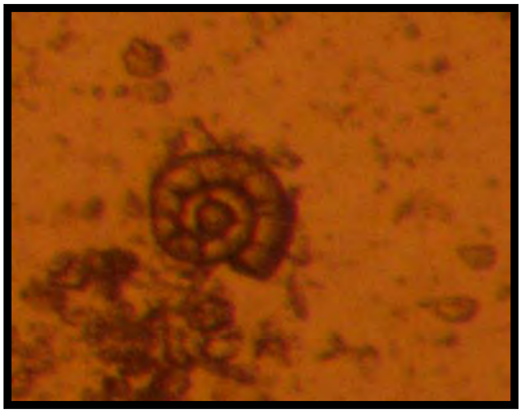
Gastropod larvae

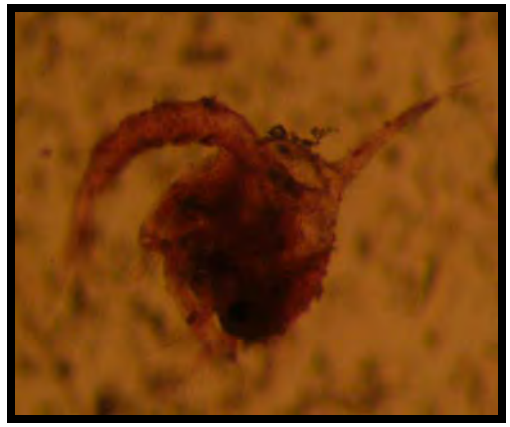
Polychaete larvae

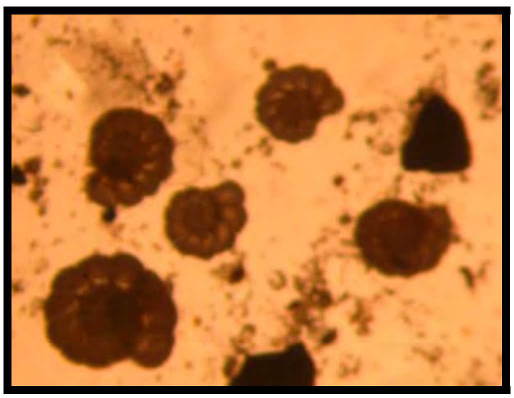


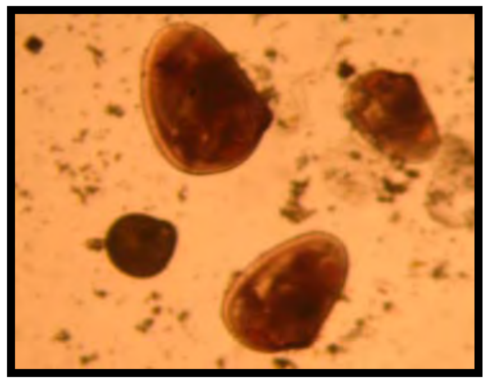
Barnacle larvae

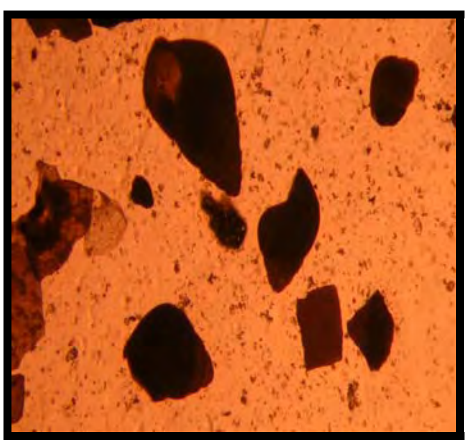
Picture: Some representative Macrofauna at Keti Bunder

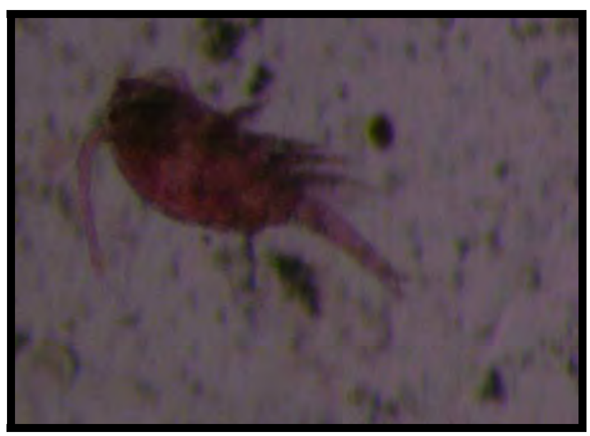






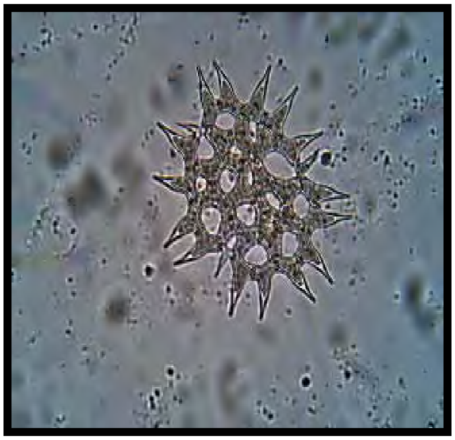






Picture of Phytoplankton at Kinjhar Lake

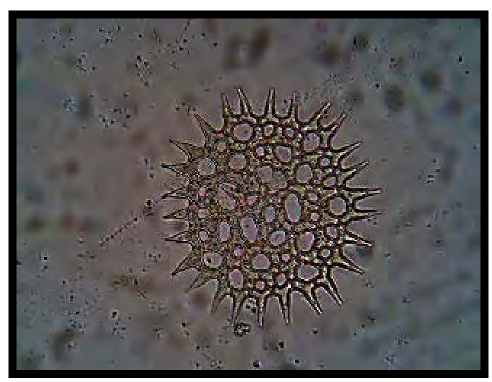
A - Phylum Chlorophyta



Pediastrum sp.

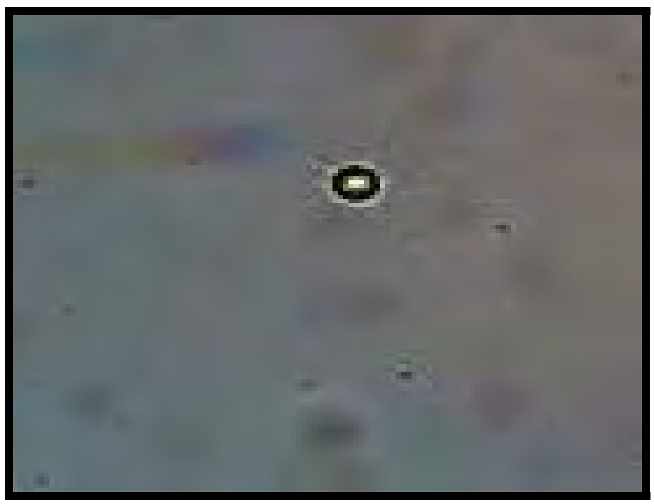
Pediastrum sp.

Pediastrum simple



Pediastrum sp.

Pediastrum clathratum

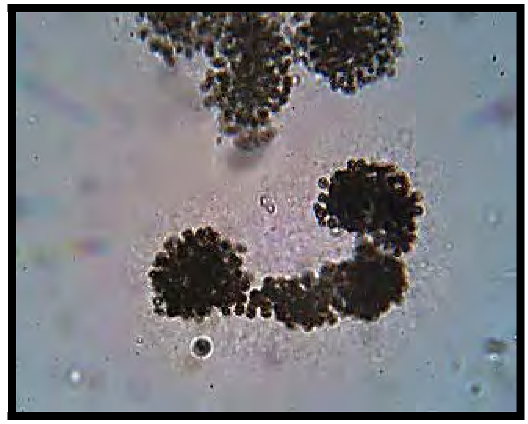


Golenkinia radiata

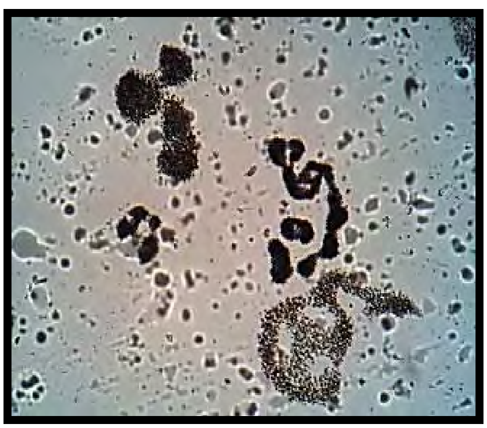
Coelastum microsporum

B – Phylum Cynophyta

Microcystis robusta (Clark) Nygaard

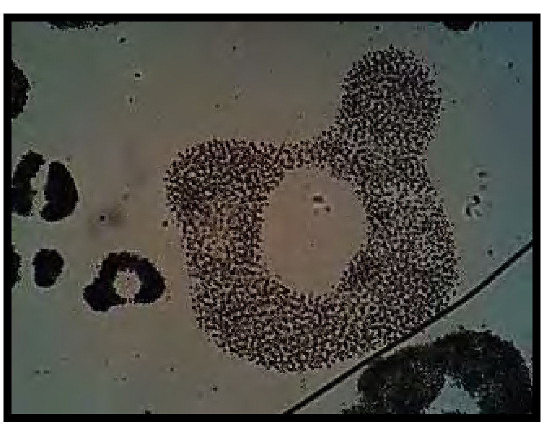


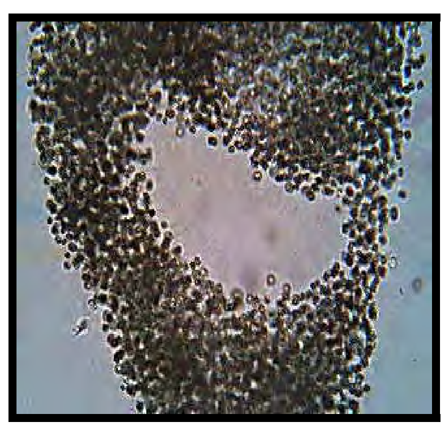
Spirulena princeps W.et G.S. West



Microcystis incerta Lemm.

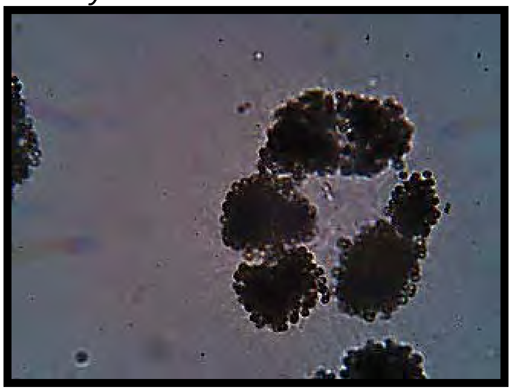
Microcystis incerta Lemm.





Microcystis incerta Lemm.

Microcystis flos-aquae (Wittr)Kirchn.



Microcystis elabens (Berb.)Kutz.

Microcystis aeruginosa v. major

Microcystis aeruginosa

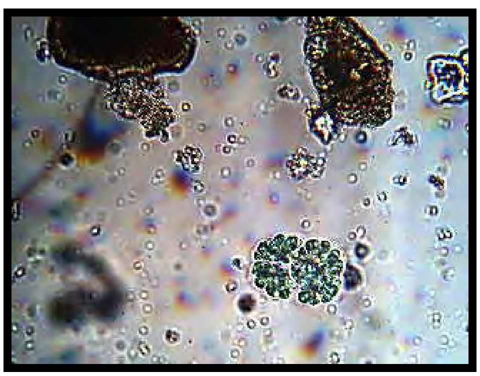
Microcystis aeruginosa f. (sphaerodictyoides Elen)

Merismopedia minima Beck.

Merismopedia glauca Rao.

Cylindrospermum staganale Kutz.

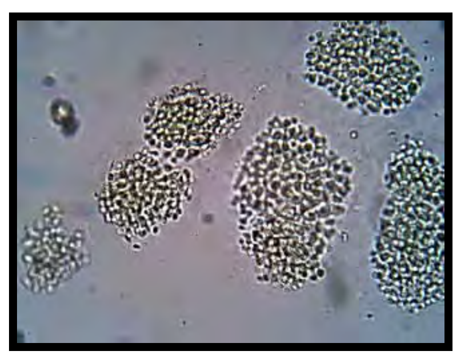
Cylindrospermum staganale Kutz.



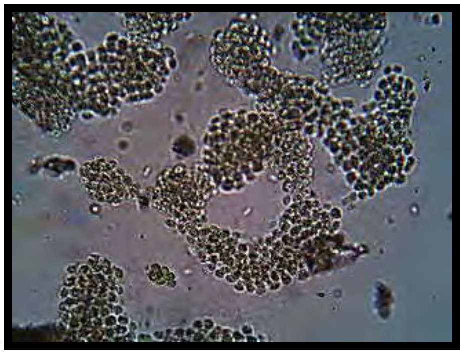
Coelosphaerium dubium Grun

Chroococcus minutus (Kutz.)Nag

Chroococcus minor (Kutz) Nag



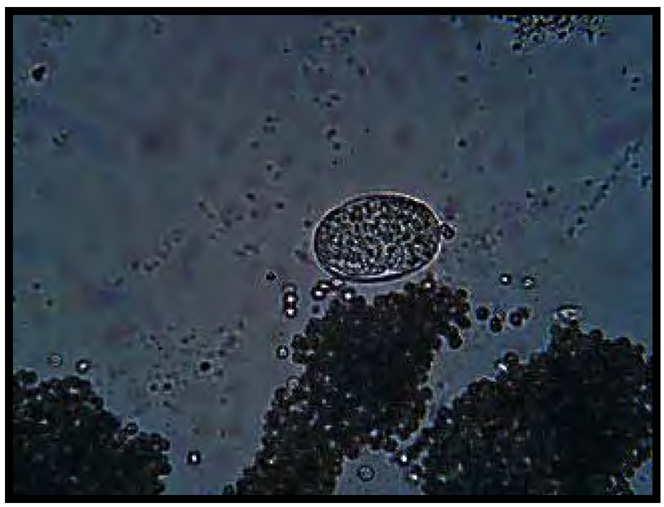
Aphanothece caldariorum Richter, P



Aphanothece saxicola Nag.

Anabaena plantonica

C – Phylum Euglenophyta



Gloeomonas ovalis Klebs.

Picture of Zooplankton at Kinjhar Lake

Simocephalus expinosus

Cyclops nupli

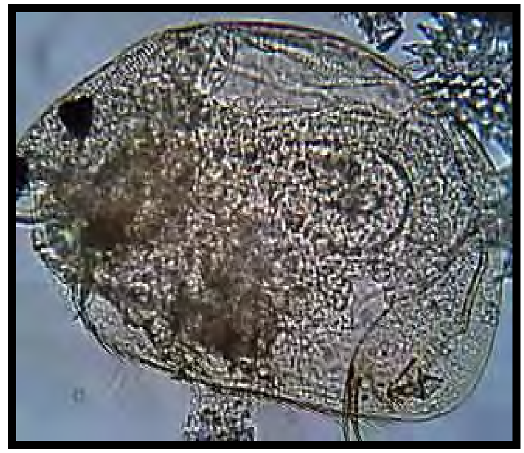
Diaphnosoma sarsi

Ceriodaphnia cornuta

Brachionus forficula

Brachionus falcatus

Brachionus diversicornis



Alona karua

Thermocyclops hyalinus

Pictures of Phytoplankton at Chotiari Reservoir

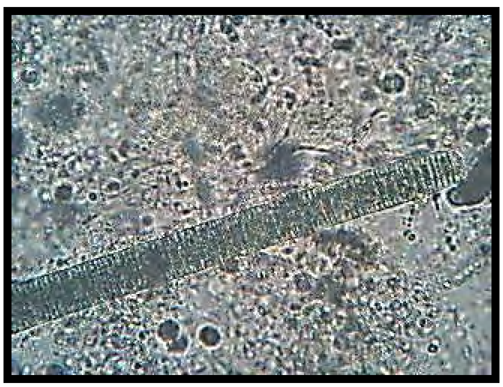
A- Phylum Cynophyta:

Xenococcus kerneri Hansg.

Spirulena princeps W.et G.SWest

Oscillatorria formosa Bory.

Oscillatoria princips



Oscillatoria princips Vauch

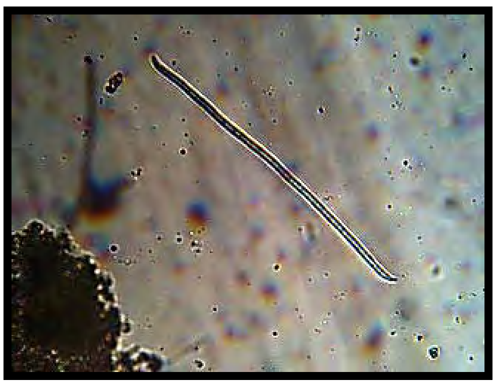
Oscillatoria principes W.et G.S.West

Oscillatoria limosa Ag. Ex. Goment

Oscillatoria limosa Ag.

Oscillatoria jasorvensis Vouk

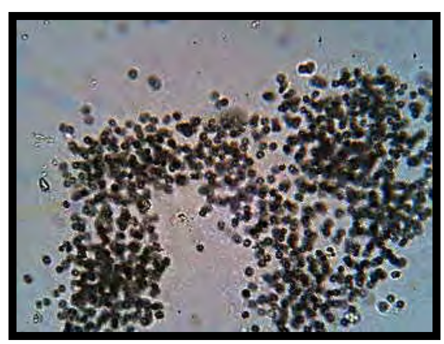
Oscillatoria formosa



Oscillatoria amphibia Ag 1.

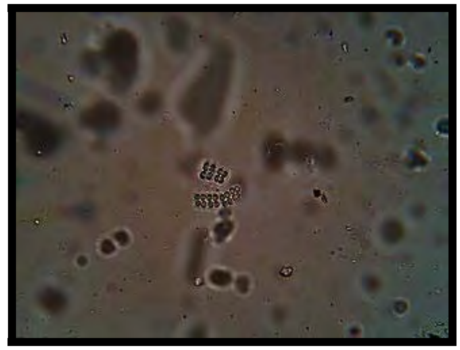
Oscillatoria amphibia Ag.2

Oscillatoria amphibia Ag.3



Microcystes robusta (Clard) Nygaard

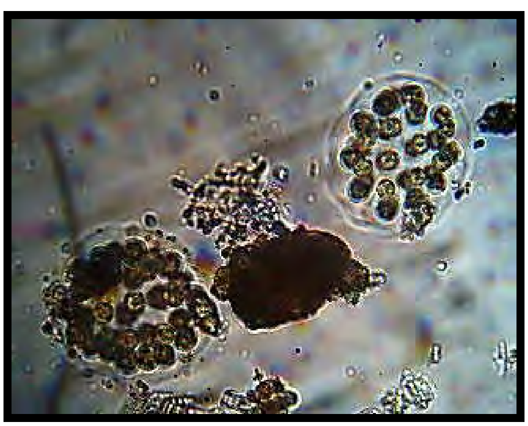
Microcystes fungal growth



Merismopedia tenuissima Lemm.

Merismoped glauca Ehrenbnag Nag

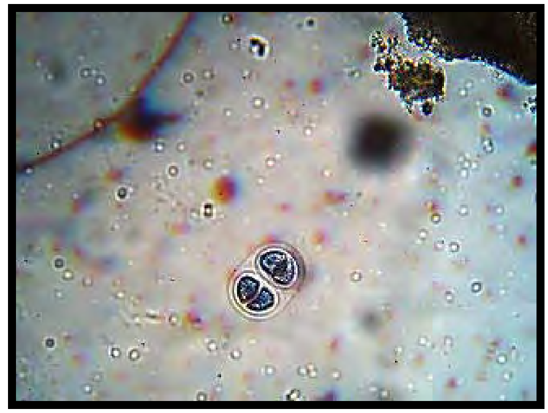
Gomphosphaeria aponina Kutz.



Gloeocapsa magma (Bereb.) Holl

Cylindrospermum staganale Kutz.

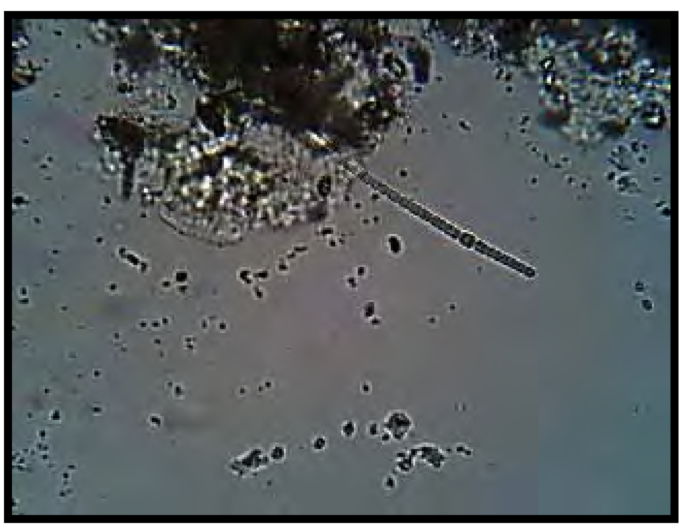
Cylindrospermum staganale Kutz



Chroococcus tenax (Kirch.) Hier

Botryococcus braunii Kutz.

Ankistrodesmus acicularis



Anabaena variabilis Kuetzing

B- Phylum Bacillariophyta:

Rhoicosphenia curvata (Kutz) Grun.

Pinneularia nobilis Ehr.

Nitzschia palea (Kutz.) W. Smith

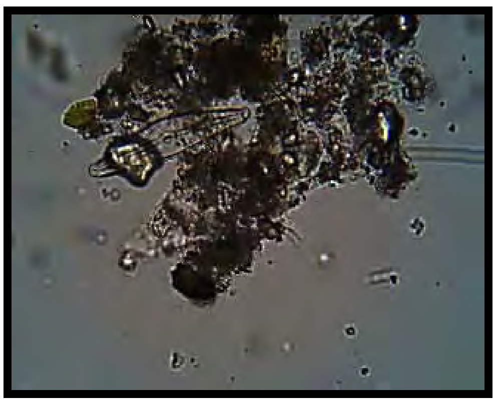
Navicula pupula Var. rectangularis (Greg)

Gomphonema parvulum var. subelliptica

Gomphonema parvulum var. subelliptica

Fragilaria capucina Desmazi.

Cymbella gracilis (Rabens.) Cl



Cymbella affinis Kutz.

Asterionella formosa Hass.

Asterionella formosa Hass

Anomoeoneis sphaerophora (Kutz.)

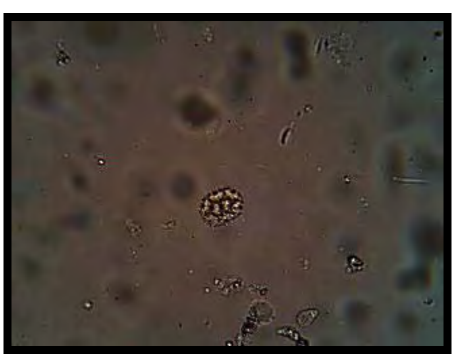
Tabellaria fenestrata (Lyngb.) Kutz.

Navicula anglica

C- Phylum Chlorophyta:

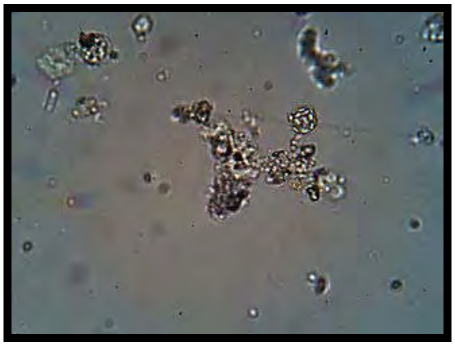
Sphaerocystis schroeteri Chod.

Pediastrum tetras (Ehr) Berb.



Pediasterium sp.

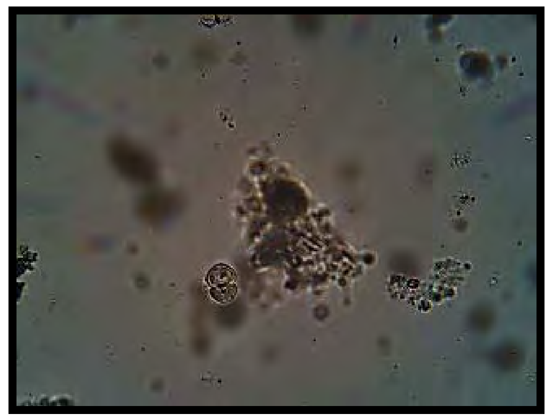
Pediasterium clathratum.



Oocystis borgei Srrow.

Cosmarium graminatum Brebission.E

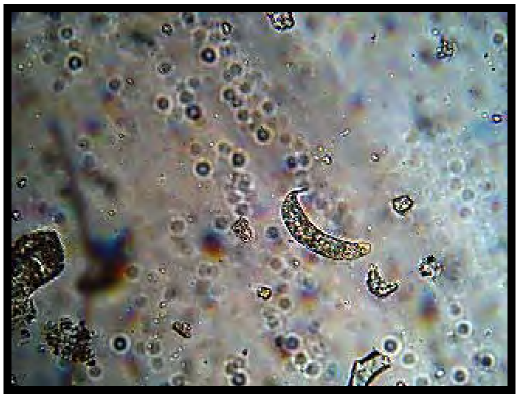
Cosmarium graminatum Brebission.E



Cosmarium deprassum Nag. Lund

Cosmarium blyttii Will

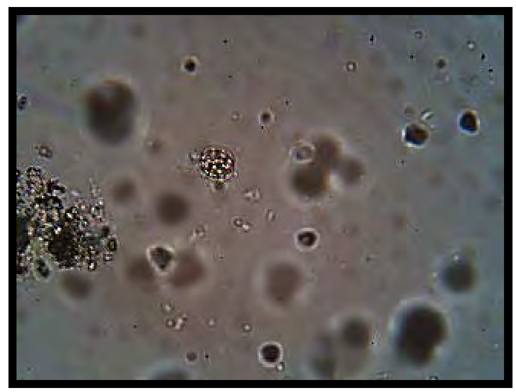
D - Phylum Euglenophyta



Euglena spirogyra Ehrenb

Euglena deses Ehrenb.

Coccomonas orbicularis Stein.



Lepocinclis longistriata Chu.

E - Phylum Pyrrophyta

Perinidium elpatiewskyi.

Perinidium elpatiewskyi

Pictures of Zooplankton of Chotiari Reservoir

Cyclops nupli

Monostyla bulla

Mesocyclops leuckerti

Keratella tropica

Diaphanosoma sarsi

Ceriodaphnia reticulate

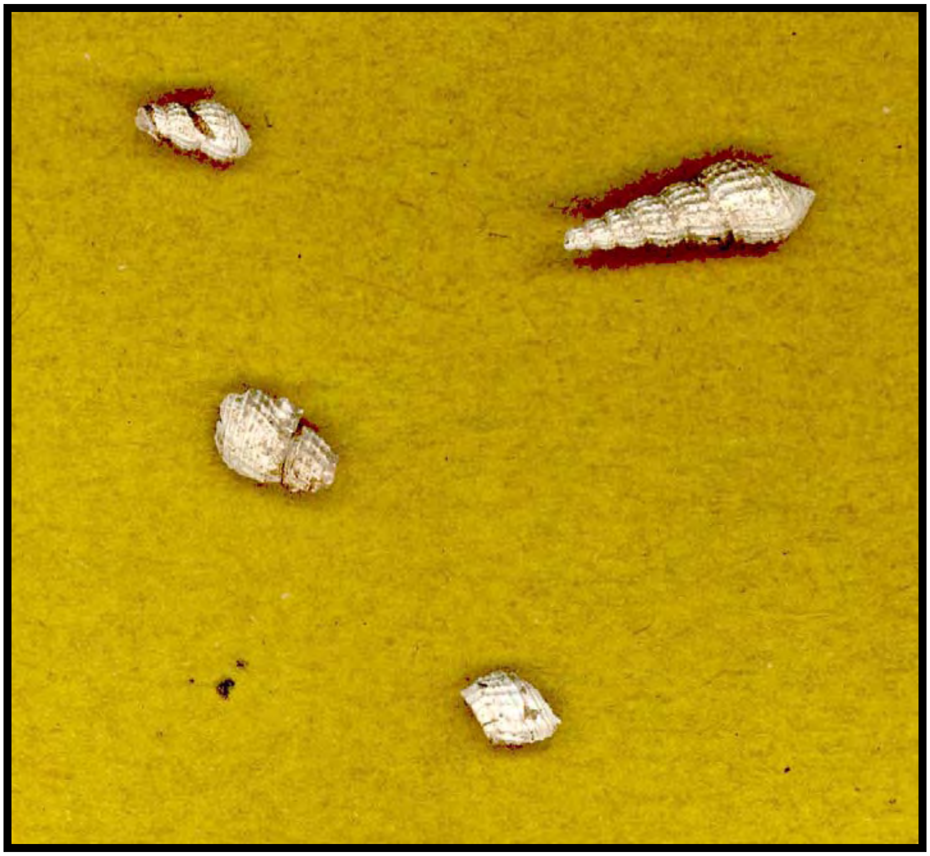
Brachionus caudatus

Bosmina longirostris

Bosmina fatalis

Bosimina coregoni

Pictures of Macrofauna observed at Kinjhar Lake and Chotiari Reservoir

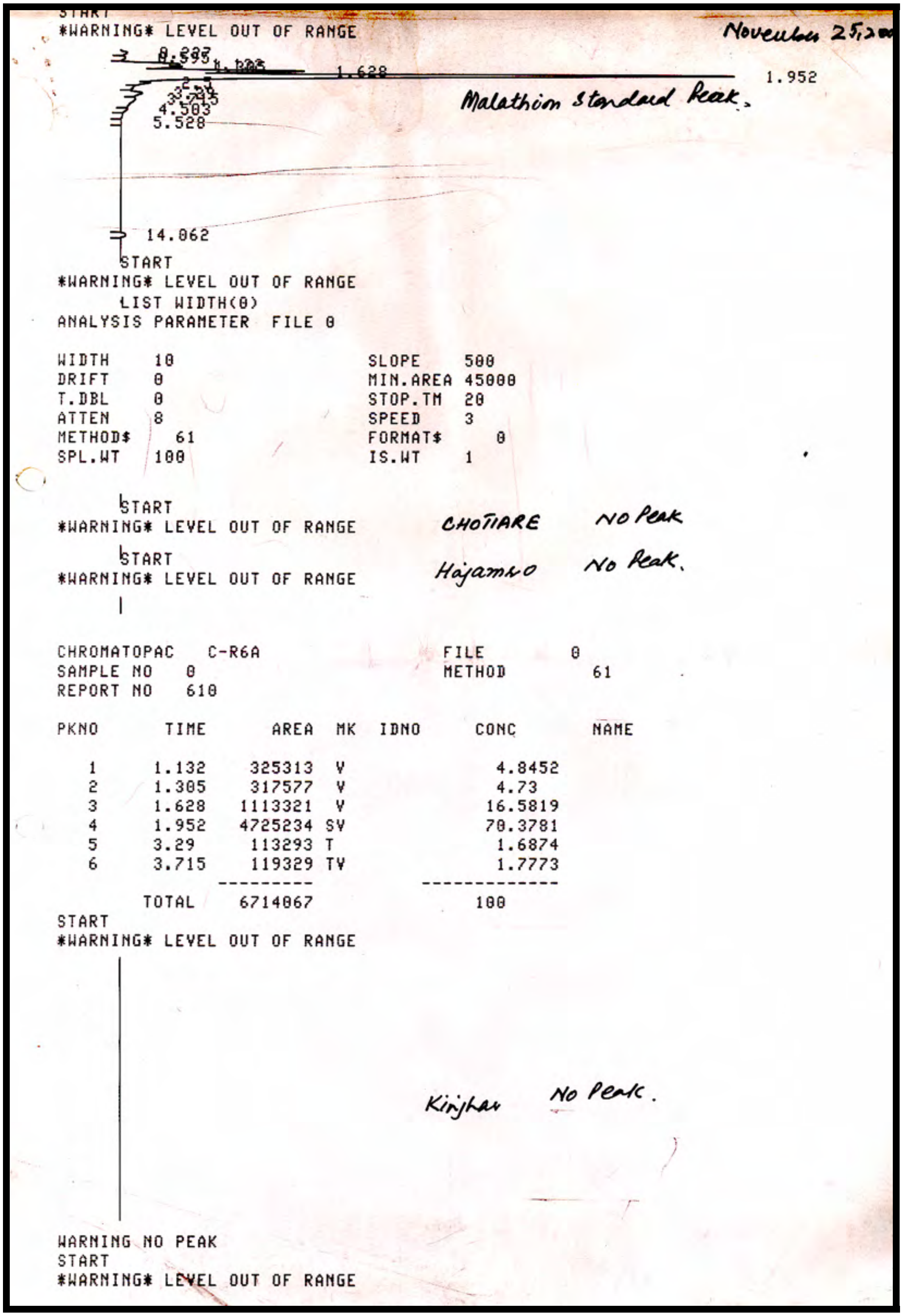


Tricula cristella (Gredler)

Lymnaea stagnalis (Linnaeus)

Gyraulus convexiusculus (Hutton)

Annex 6 Results of Chromatography for Pesticides



START
WARNING LEVEL OUT OF RANGE
November 25, 200

1.628
1.952
Malathion standard Peak.
4.503
5.528

14.062
START
WARNING LEVEL OUT OF RANGE
LIST WIDTH(0)
ANALYSIS PARAMETER FILE 0

WIDTH	10	SLOPE	500
DRIFT	0	MIN.AREA	45000
T.DBL	0	STOP.TM	20
ATTEN	8	SPEED	3
METHOD$	61	FORMAT$	0
SPL.WT	100	IS.WT	1

START
WARNING LEVEL OUT OF RANGE CHOTIARE NO Peak
START
WARNING LEVEL OUT OF RANGE Hajamro No Peak.

CHROMATOPAC C-R6A FILE 0
SAMPLE NO 0 METHOD 61
REPORT NO 610

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	1.132	325313	V		4.8452	
2	1.305	317577	V		4.73	
3	1.628	1113321	V		16.5819	
4	1.952	4725234	SV		70.3781	
5	3.29	113293	T		1.6874	
6	3.715	119329	TV		1.7773	
	TOTAL	6714067			100	

START
WARNING LEVEL OUT OF RANGE

Kinjhar No Peak.

WARNING NO PEAK
START
WARNING LEVEL OUT OF RANGE

Commercially use pesticides (Malathione, Cypermetherine, Aldrin,Dialdrin) Other Pesticides

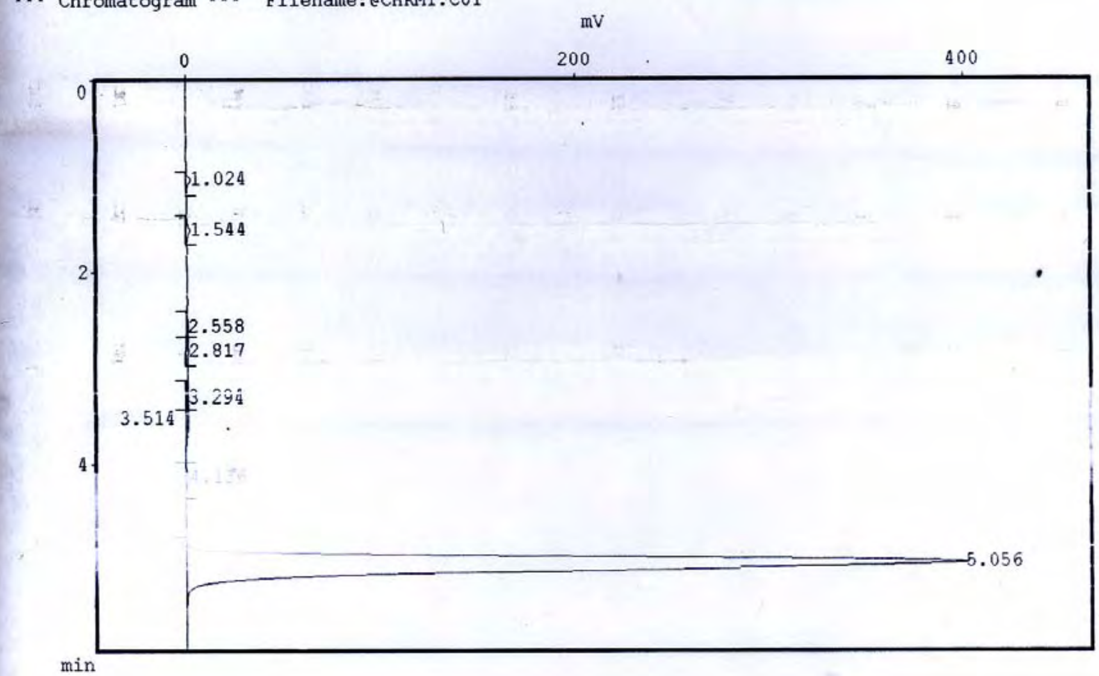
CLASS-LC10 Ver.=1.63 SYS=1 Ch=1 REPORT.NO=1 DATA=@CHRM1.D01 06/11/28 09:31:32

Std. Pendi.

Pendimethin

Sample :
ID :
Type : Unknown
Detector : Other
Operator : MSQ
Method Name : STOMP.MET

*** Chromatogram *** Filename:@CHRM1.C01



*** Peak Report ***

PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1.024	13186	2200	V		0.3477	
2	1.544	20946	2297	V		0.5523	
3	2.558	12002	803	V		0.3165	
4	2.817	17943	1298	V		0.4731	
5	3.294	17885	1105	V		0.4716	
6	3.514	18766	1047	V		0.4948	
7	4.136	14581	1846			0.3845	
8	5.056	3677068	402595			96.9595	
		3792376	413191			100.0000	

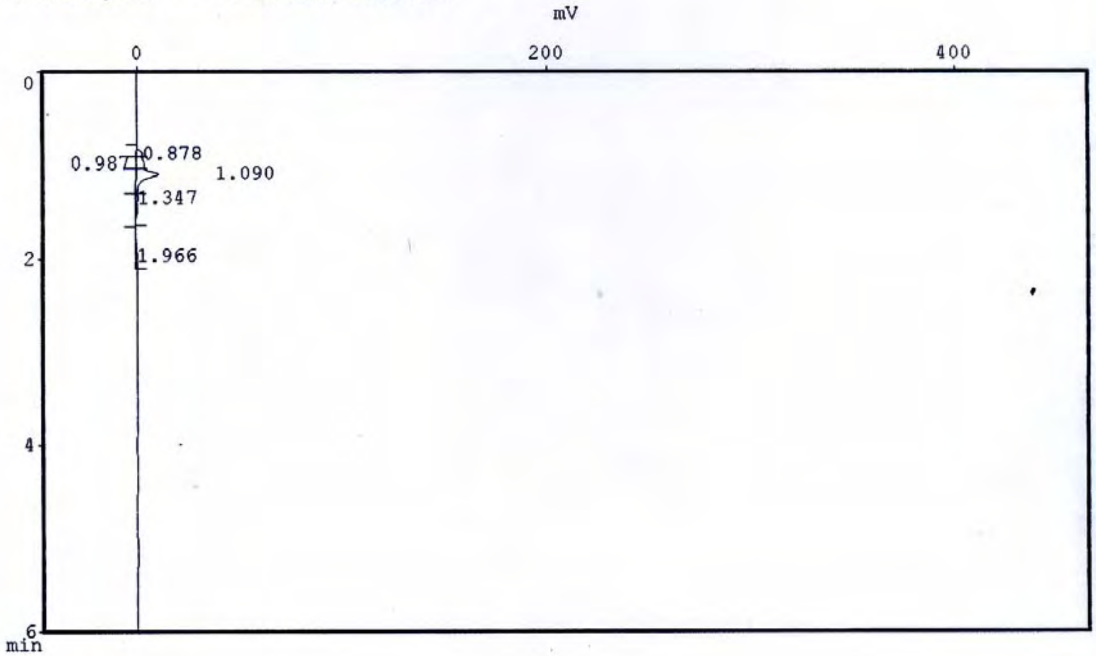
1 - 1/1 06/11/28 09:37:43

D T water

CLASS-LC10 Ver.=1.63 SYS=1 Ch=1 REPORT.NO=2 DATA=@CHRM1.D02 06/11/28 09:38:12

Sample :
ID :
Type : Unknown
Detector : Other
Operator : MSQ
Method Name : STOMP.MET

*** Chromatogram *** Filename:@CHRM1.C02



*** Peak Report ***

PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	0.878	11488	2823			8.9832	
2	0.987	25183	4033	V		19.6922	
3	1.090	66567	10931	V		52.0520	
4	1.347	13367	900	V		10.4520	
5	1.966	11280	643			8.8206	
		127885	19329			100.0000	

8.386
9.85

2 - 1/1

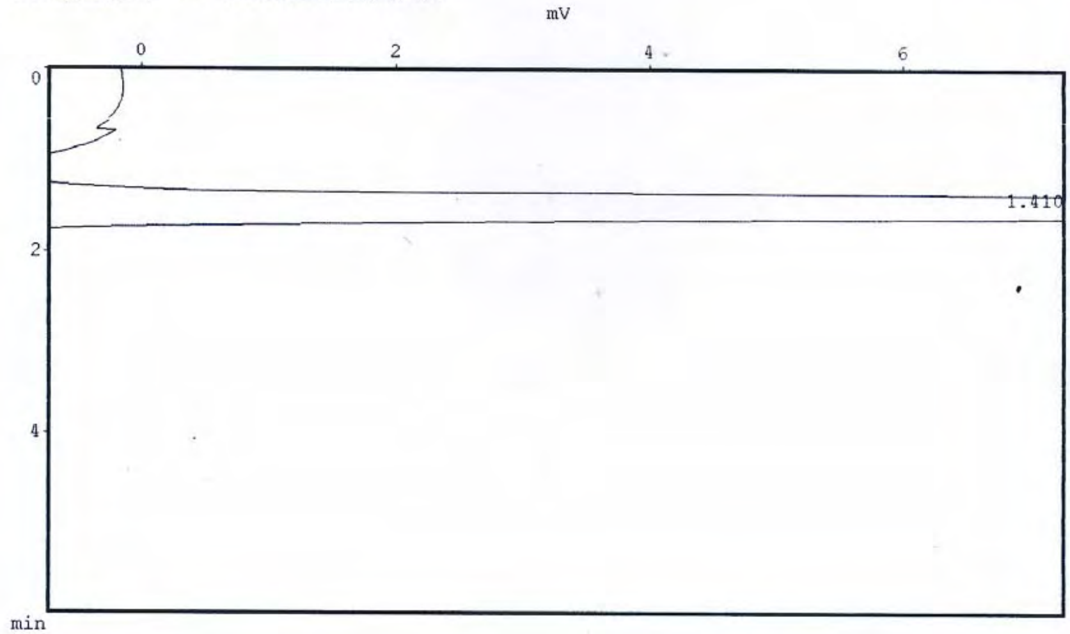
06/11/28 09:44:25

80:20
ACN:H_2O
240
KT Bandar
Pendi
Pendi
Quattro.

CLASS-LC10 Ver.=1.63 SYS=1 Ch=1 REPORT.NO=3 DATA=@CHRM1.D03 06/11/28 09:49:18

Sample :
ID :
Type : Unknown
Detector : Other
Operator : MSQ
Method Name : STOMP.MET

*** Chromatogram *** Filename:@CHRM1.C03



*** Peak Report ***

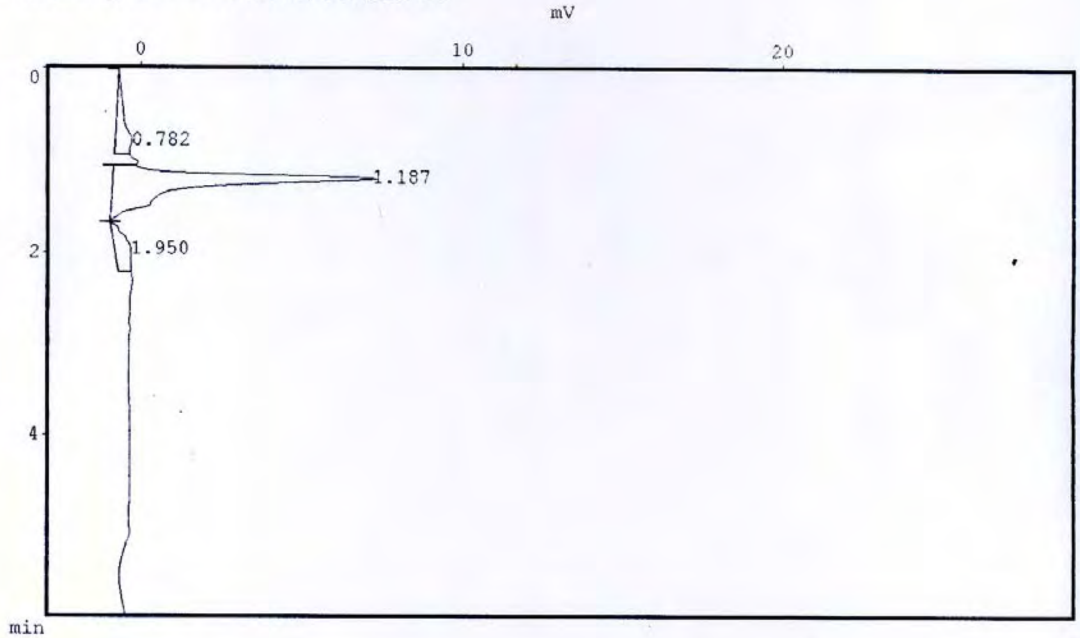
PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1.410	457207	37162			100.0000	
		457207	37162			100.0000	

3 - 1/1 06/11/28 09:55:26

```
CLASS-LC10 Ver.=1.63  SYS=1 Ch=1 REPORT.NO=4  DATA=@CHRM1.D04 06/11/28 09:56:48
Sample        :
ID            :
Type          : Unknown
Detector      : Other
Operator      : MSQ
Method Name   : STOMP.MET
```

Station
Pendi
Quattro.

*** Chromatogram ***   Filename:@CHRM1.C04



*** Peak Report ***

PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	0.782	13359	524			13.1369	
2	1.187	75869	8176	V		74.6062	
3	1.950	12465	499			12.2570	
		101693	9199			100.0000	

8.30.
9.80.

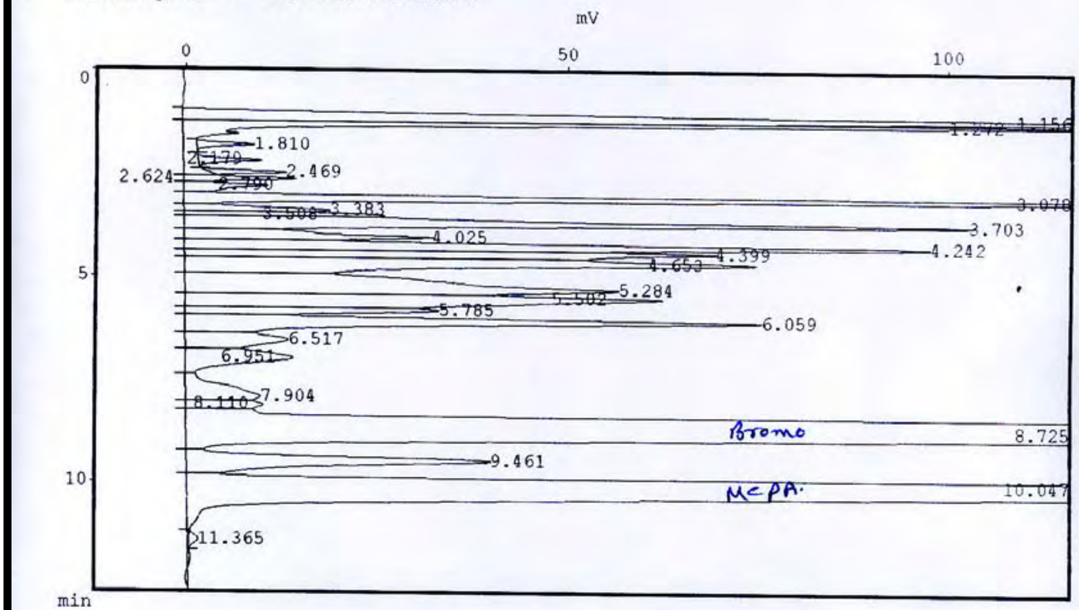
4 - 1/1   06/11/28 10:02:56

CLASS-LC10 Ver.=1.63 SYS=1 Ch=1 REPORT.NO=6 DATA=@CHRM1.D06 06/11/28 11:00:16

Bromo + MCPA

Sample :
ID :
Type : Unknown
Detector : Other
Operator : MSQ
Method Name : STOMP.MET

*** Chromatogram *** Filename:@CHRM1.C06



*** Peak Report ***

PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1.156	1273599	176300			2.9486	
2	1.272	906365	138004	SV		2.0984	
3	1.810	46214	7573	T		0.1070	
4	2.179	51281	8339	T		0.1187	
5	2.469	49629	10156	T		0.1149	
6	2.624	89363	14704	V		0.2069	
7	2.790	102199	11115	V		0.2366	
8	3.078	1174797	192266	V		2.7199	
9	3.383	130231	19120	V		0.3015	
10	3.508	162218	26184	V		0.3756	
11	3.703	968274	103744	V		2.2418	
12	4.025	335836	32539	V		0.7775	
13	4.242	884144	97983	V		2.0470	
14	4.399	693756	69744	V		1.6062	
15	4.653	1023367	75012	V		2.3693	
16	5.284	1136145	56960	V		2.6304	
17	5.502	950738	62666	V		2.2012	
18	5.785	288194	33282	V		0.6672	
19	6.059	885609	75847	V		2.0504	
20	6.517	255566	13518	V		0.5917	
21	6.951	286390	14069	V		0.6631	
22	7.904	222799	9768	V		0.5158	
23	8.110	127565	10121	V		0.2953	
24	8.725	23415915	996822	VE		54.2127	
25	9.461	606348	39860	V		1.4038	
26	10.047	7110038	366561	SV		16.4612	
27	11.365	16113	1167	T		0.0373	
		43192693	2663425			100.0000	

K-T

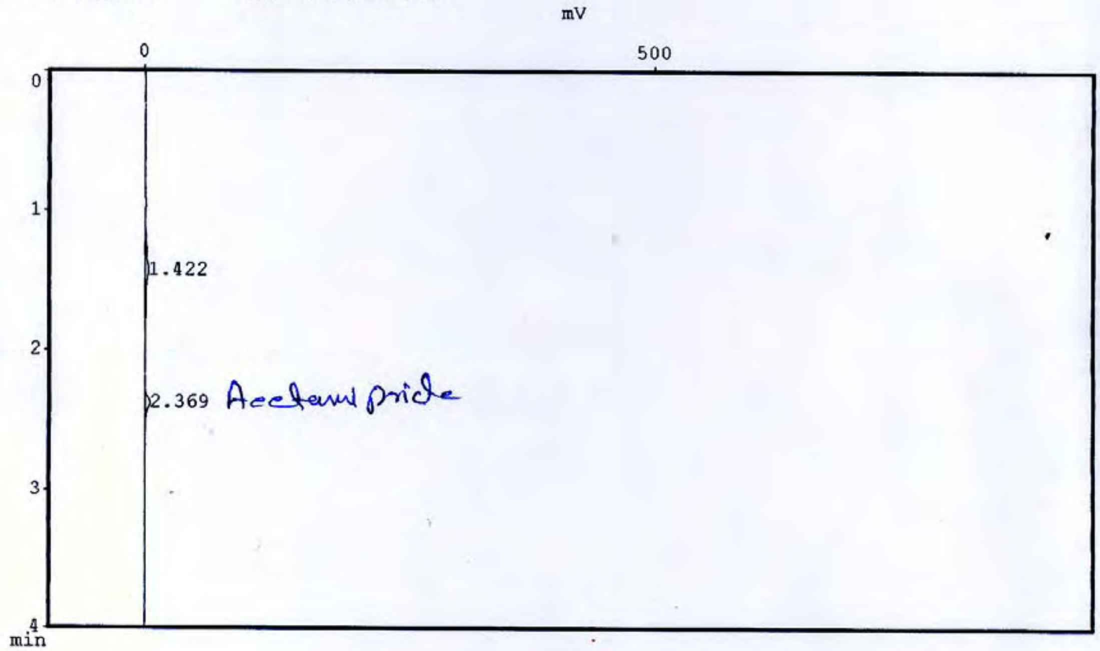
Bandar

CLASS-LC10 Ver.=1.63 SYS=1 Ch=1 REPORT.NO=14 DATA=@CHRM1.D14 06/11/29 14:32:44

Sample :
ID :
Inj. Volume : 1
Type : Unknown
Detector : Other
Operator : MSQ
Method Name : TITONMET.MET

tobe attached

*** Chromatogram *** Filename:@CHRM1.C14



*** Peak Report ***

PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1.422	67685	3617	V		69.7246	
2	2.369	29390	4724	SV		30.2754	
		97075	8341			100.0000	

Lambdacyhalothrin, Myalin and Acetamiprid are standards used and also in the present investigation.

Following pesticides were present in the sample that need to be further investigate.

Acetamiprid present in Keti Bunder sample.

Acetamiprid present in Chotiari sample.

Myalin was also detected in Keti Bunder.

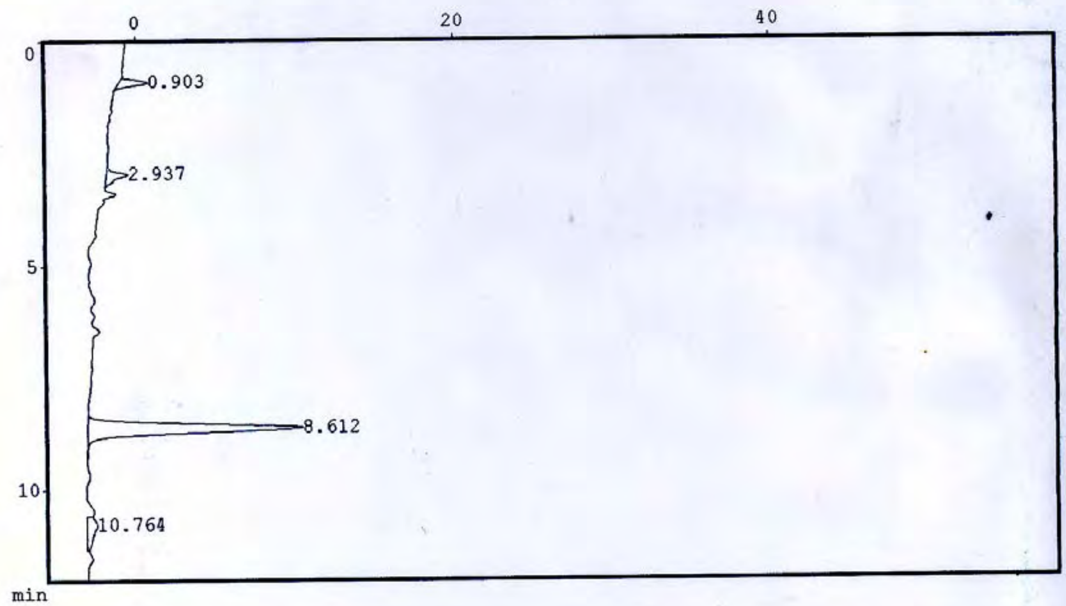
14 - 1/1 06/11/29 14:36:50

CLASS-LC10 Ver.=1.63 SYS=1 Ch=1 REPORT.NO=15 DATA=@CHRM1.D15 06/11/29 14:58:42

Mialyzing.
std.
Mialyzin
fo Palacio
Jose attarun

Sample :
ID :
Inj. Volume : 1
Type : Unknown
Detector : Other
Operator : MSQ
Method Name : TITONMET.MET

*** Chromatogram *** Filename:@CHRM1.C15



*** Peak Report ***

PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	0.903	14785	1813			6.4714	
2	2.937	14649	1373			6.4118	
3	8.612	181360	13540			79.3808	
4	10.764	17674	633	V		7.7360	
		228468	17359			100.0000	

15 - 1/1

06/11/29 15:10:53

Annex 7 Pictures of Field work

Sampling at Keti Bunder

Pictures of Study Sites

Keti Bunder

Chotiari Reservoir

Different views of Kinjhar Lake

Kinjhar Lake