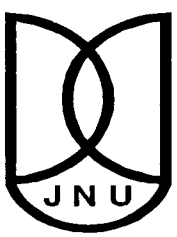
AN ENDANGERED ECOSYSTEM OF WETLAND: A CASE STUDY OF KEOLADEO NATIONAL PARK, BHARATPUR

Dissertation submitted to the Jawaharlal Nehru University in partial fulfillment of the requirement for the award of the degree of

MASTER OF PHILOSOPHY

PRASHANT KUMAR



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JAWAHARLAL NEHRU UNIVERSITY
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INDIA
2006

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DECLARATION

I, **PRASHANT KUMAR**, certify that the dissertation entitled "**AN ENDANGERED ECOSYSTEM OF WETLAND: A CASE STUDY OF KEOLADEO NATIONAL PARK, BHARATPUR**" is my bonafide work and may be placed before the examiners for evaluation.

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Dedicated

in the loving memory of

my dada ji, Late Sh. Pratap Singh Jaghina,

and my ammu ji, Late Smt. Madan Kaur.

ACKNOWLEDGEMENT

There are personalities who simply by being what they are influence and inspire to do things that you never thought to do and to leave your imprints for ever.

At the very onset, I pay my sincere gratitude to my supervisor, Prof. Harjit Singh, for his invaluable guidance and scholarly ideas. He not only indicated towards mistakes but also helped in correcting them. I have been able to complete this strenuous assignment owing to his supervision and support.

I am also grateful to other faculty members of CSRD, for they all have been very kind in providing every possible help towards this dissertation.

I pay my regards to Mr. Kali Charan Verma (Ranger, KNP) and Dr. Harendra Singh (WWF, KNP) and the library staff of Documentation Unit (CSRD), JNU Central Library, INSDOC, International Crane Foundation (New Delhi) and Forest Department, KNP (Bharatpur) who helped me in providing material related to my study.

I also pay my regards to Mr. Binay (Lecturer, M.S.J. College, Bharatpur) and my Nana Ji (Mr. Giriraj Singh), for they made me conscious about the fragile ecosystem of Keoladeo wetland.

I thank my friend, Payal, for her soothing mental support and for being always there for me and helping me through all evens and odds. Without her, this task wouldn't be possible.

I will always be deeply indebted to my father, Mr. Prabhav Singh and my mother Mrs. Kusum Lata for their encouragement, support and unconditional love throughout my life. In addition, I thank my brother Nishant, Taau Ji (Mr. Tikam Singh), Mrs. and Mr. Lalit Magazine, Dr. Shivdev Singh, Mr. Om Prakash Solanki, Gupta uncle ji and family and Mrs. and Mr. Udhav Poddar for their forever support. I also thank Tuhin, Sharad, Sanjay, Thalesh, Sushil, and Subhash for their motivation and cooperation.

PRASHANT KUMAR

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Chapter 1

AN INTRODUCTION TO THE THEME

1.1 INTRODUCTION:

Wetlands, as the term implies, are 'Wet' lands that exist because of the inflow of water exceeds the outflow for brief to extended periods of time during the growing seasons. Wetlands receive water from precipitation, snow melt, river outflow, surface overland flow, ground water discharge, lakes, ponds and irrigation systems. Wetlands play an important and active role in taking care of nature's balance. Some of wetland's important functions include – flood control, water storage and purification, recharge of ground water, gene pool construction, sedimentation etc. along with providing food, fuel, fodder and fiber. Most of the natural wetland functions are closely related to wetland hydrology. Wetland food chain, fish and wildlife habitat value, nutrient cycling, socio-economic values, heritage, and even aesthetic values are tied to the source, velocity, frequency, timing and quantity of water. Wetlands occur extensively throughout the world in all climatic zones. These are estimated to cover about 6 per cent of the land surface. These include a wide spectrum of habitats ranging from the extensive peat bogs of northern latitudes to tropical mangrove forests, from seasonal forest ponds and marshes to flood plains and permanent riparian swamps. These are extended from fresh water shallow lakes and margins of large reservoirs to salt lakes, brackish lagoons, estuaries and costal salt marshes[1].

Wetlands have intrinsic ecological and environmental values. Besides, human beings use wetlands for many commercial purposes including fishing, transportation, irrigation and industrial water supply. Their moderate temperature affects the climate of the surrounding area. By storing water these help in regulating stream flow, recharge ground water aquifers and in moderating droughts. These provide habitat to aquatic and semi aquatic plants and animals, which in turn provide food to many terrestrial animals adding to the biodiversity. Wetlands have supported human beings since time immemorial. One of the wetland plants, RICE, was domesticated and has become main staple food for more than half of the world's human population[2]. These are intimately associated with the economic and cultural aspects of human beings. For instance, many people subsist on 'snail-catching' during rainy season when they can not go out for fishing.

Generally, wetlands are treated as "only water bodies" and not as separate ecosystem and therefore attention has been focused on deriving maximum economic benefits out of these. It is not appropriate to view wetland only as water body and not as a separate ecosystem. Wetlands are highly dynamic systems which continually interact with other ecosystems in their catchments and also face human impact in variety of ways. It is necessary, therefore, to manage them scientifically so that their ecological attributes do not get severely altered.

The myriad ways in which humans use wetlands, along with numerous pollutant generating activities of society, have stressed wetland ecosystems in diverse ways, frequently causing impairment of their quality for other uses. Stresses to water bodies arise from easily identifiable point sources such as municipal and industrial waste water, non-point degradation like urban and agricultural run-off within a wetland area, and the most insidious long-range atmospheric transport of contaminants. Major degradation factors include excessive eutrophication due to nutrient and organic matter loading; siltation due to inadequate erosion control in agricultural, construction, logging and mining drainage; and contamination by toxic or potentially toxic metals such as mercury and pesticides.

Ironically 'wetlands' have been nearly an untouched research area for geographers and also these are not given proper attention in relation to conservation and sustainable development. Very less information and ill awareness regarding wetlands are also important reasons behind deteriorating possibilities of their conservation and utilization. It is ironical that while the developed countries of the west are very sensitive to some aspects of environmental protection, these are finding it difficult to resist the pressure for commercial exploitation of certain sectors of these natural patrimonies. In the southern hemisphere, 90 per cent of New Zealand and 50 per cent Australian wetlands are reported to have disappeared since the Europeans settled there 200 years ago[3].

India is also richly endowed with wetlands as is evident from the high-altitude lakes of the Himalayas; floodplain wetlands of major river systems and their extensive network of tributaries. These are fragile ecosystems that are susceptible to damage even with only a little change in the composition of biotic and abiotic factors. These are

threatened due to inadequate water holding capacity, excessive withdrawal, pollution due to release of raw sewage and sullage, industrial effluents, eutrophication, leached fertilizers and insecticides. The degradation in the water quality affects the floral and faunal population along with the people dependent on these ecosystems. Surveys indicate that lakes with water quality confirming to the prescribed standards have a high economic dependence, whereas it may be low for lakes where eutrophication has taken place[4].

Most of the developmental activities are currently concentrated in and around cities and towns in India. This has led to large-scale migration of population during the last two and half decades. This in turn has created lot of pressure on the existing water bodies. Water supply and Sewerage Boards in various cities are unable to meet the requirements of potable water due to shrinking water resources like lakes, ponds and wells etc. Disappearance of lakes and ponds in cities is directly responsible for lowering the ground water table, which has lowered from 80 feet to 300 feet in certain cities[5]. Increasing demand for potable water necessitates the search for environmentally sound alternate water resources and also for the prevention and well equipped management of remaining lakes, ponds and wells.

1.2 WHAT IS A WETLAND

The major problem in the present study is to find a proper definition of "wetland". Many terms are used in India while referring to wetlands. These include terms like 'Chaurs' in Bihar, 'Bhills' in Assam and northeast India, 'Tals' in U.P. and M.P. and 'Tar bhumi' in Rajasthan and Haryana[6]. Definition of wetland satisfying the needs of researchers and students is still awaited as the definition of 'wetland' depends upon the obejectives of a researcher in different study areas. In this light, geologists, geographers, hydrologists, biologists, environmentalists, sociologist, economists and lawyers have suggested different definitions. Depending on the various view points, this has created a huge gap in the consensus on the commonly accepted definition of wetland. However, some of the more commonly used definitions have been reproduced below:

'Wetlands are areas of marshes, fen, peatland, permanent or temporary, with water that is static or flowing, fresh, brackish or salty, including areas of marine water, the depth of

which at low tide does not exceed six meters'. This definition evolved in 'RAMSAR CONVENTION' (1971) by International Union for the Conservation of Nature (IUCN).

'Wetlands are lands or areas transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water', Cowardin (1979)[7].

The second definition has wider acceptance among scientists and planners. It is flexible and descriptive in nature. The Indian Government has officially adopted this definition.

Thus, a general definition for wetlands could be set that wetlands are basically water logged lands where the soil is saturated with water at least sometime during a year. A lot of land is water logged during rainy season but it does not mean that all this land is 'wetland'. Wetlands are mostly characterized by specific plants and animals, which are particularly adapted to water logging of soils during their growth period.

Cowardin and associates have recognized the problems those restrict the evolution of well set and non-controversial ecological definition. These problems are due to diversification between wetlands and hierarchical differentiation between 'wetlands' and 'dry lands'. Thus, without a commonly accepted definition and technical terminology, neither wetlands can be accurately mapped nor their exact area be assessed.

'The World Wetland Day' is celebrated on February 2 every year. The Ramsar Convention was initially meant for conservation of wetland birds. Later, it was realized that wetland ecosystems are cradles of biodiversity upon which, besides birds, countless species of plants and animals depend for survival. Of the 20,000 species of fish in the world, more than 40 percent live in fresh water[8]. Wetlands are renowned for high levels of endemic species, especially fish and invertebrates. Many varieties of prawn, mollusk and insects are found only in the wetlands. Therefore, the theme of The World Wetland Day is "Wetlands: Water, life and culture".

1.3 CLASSIFICATION AND TYPES OF WETLANDS

Every natural and artificial entity that is a subject of research needs to be classified in a scientific way. Wetlands, being both natural as well as manmade, are classified differently by scientists, researchers, environmentalists and geographers. Wetlands include a wide spectrum of habitats ranging from extensive peat bogs of northern latitudes to tropical mangrove forests, from seasonal ponds and marshes to floodplains and permanent swamps, from fresh water shallow lakes to salt lakes, brackish lagoons, estuaries and coastal marshes. Thus, wetlands exhibit very large variety in their habitat characteristics. Wetlands also occur in all sizes and shapes ranging from less than one hectare to hundreds of square kilometers in area.

In very general terms, wetlands are distinguished by latitudes – temperate and tropical. More than fifty schemes of classification have been proposed for wetlands in different countries. But there is hardly any one scheme that satisfies all scientific criteria. The simplest classification is the one proposed by Scott (1989a) for use in Ramsar Convention, and followed in the dictionary of Asian Wetlands (1989b)[9]. It simply recognizes 22 wetland types. The revised Dictionary of Indian Wetlands has adopted the same classification (WWF/AWB, 1993).

Cowardin et al have developed the most comprehensive and elaborate hierarchical system of classifying wetlands in 1979 for the United States Fish and Wildlife Services[10] (fig.1.1). It also covers the deepwater habitats. It recognizes five major systems – Marine, Estuarine, Riverine, Lacustrine and Palustrine. These have been divided into subsystems based on the nature and extent of flooding.

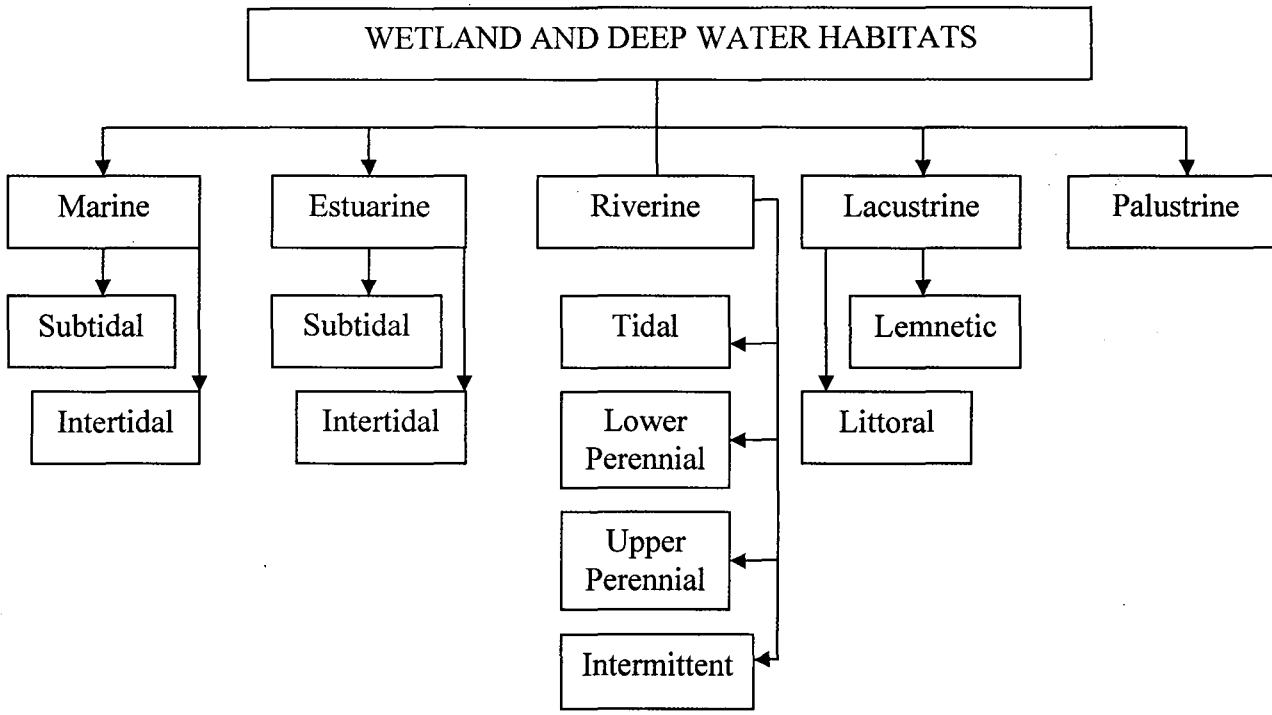

Fig.1.1, Hierarchical classification of wetlands and deepwater habitats, according to Cowardin *et al.* (1979)

Dugan (1990) suggested a classification very similar to the Cowardin system. He has grouped wetlands first into salt water, fresh water and man-made wetlands. These have been further subdivided into categories based on their hydrological characteristics[11].

Recently, Brij Gopal and Sharma (1995) have proposed a general classification scheme that can be very useful guide for surveying Indian wetlands[12]. In the proposed scheme, wetlands are first grouped into saline and freshwater types which are then distinguished based on vegetation i.e. herbaceous or woody. These categories are further divided on the basis of their hydrological regimes, particularly the duration of flooding.

It is also necessary to recognize a distinction between the natural and anthropogenic (man-made) wetlands. In fact, presently there are more man-made aquatic habitats than natural ones in India. Beside large area under paddy fields, there are many fish ponds and shallow reservoirs. Most of these man made wetlands are managed for some specific economic activities. Wetlands occur all over the world in every climate. Because of strong association of wetlands with life of early people, same kinds of

wetlands in different countries are known by different names like marshes, swamps, mires etc.

Marshes

It is a type of wetland which in Europe, often reflects the language of wetland ecosystem. The village of Marske in northeast England derives its name from the Old English 'mersc' (marsh); more obvious links are evident in towns like Crakemarsh and Tidmarsh[13]. Marshes are dominated by herbaceous plants and sustained by water sources other than direct rainfall. These are among most productive systems in the world. A vital link between terrestrial and aquatic environments, these sustain important fisheries and protect land from erosion.

Water flowing into marshes supplies the marsh system with nutrients. This distinguishes them from 'bogs', which are essentially rain fed and low in nutrients. Marshes are commonly found in wet areas of floodplains and around the fringes of permanent water bodies varying from small ponds to large lakes.

Swamps

Swamps develop in areas of still water like around lake margins, and in parts of floodplain such as slough or oxbow – often described as 'back swamps'. Reed swamps are among more productive ecological systems on earth. These are dominated by various reed species.

While mangrove swamps have forests which tolerate salt and occupy the inter-tidal zone. These constitute a reservoir and refuge for many unusual plants and animals; about 60 species of mangrove trees and shrubs, and over 2000 species of fish, invertebrates and epiphytic plants depend on mangrove swamps. These have been playing important economic role since early times. These have provided a wide range of timber products and other material on a sustainable basis.

Peat lands

These are type of wetlands and are also called 'mires'. These occur at places where plants die and begin to decompose. Normally with the help of microbes, plant tissues oxidize and eventually turn into carbon dioxide and water. But many times low

temperature, high acidity, low nutrient supply, water logging and oxygen deficiency slow down decomposition, and plant matter does not oxidize, but instead accumulates and transforms into peat.

Peat is usually called 'peat' when the depth of plant material is more than 40 cm and it does not turn into organic soil layer. Peat lands have a high water table maintained directly by rain and snow, which also maintains water logging and reduces oxygen levels. The rainfall leaches out base materials, making low in nutrients. Bogs are characterized by acid-loving vegetation such as cotton grass, purple moor grass, rushes, sedges and mosses. Peat is a sink of plant remains, nutrients and carbons. The conversion of peat into agriculture land changes these from carbon 'sinks' to carbon sources. It releases carbon into atmosphere and increases CO level which becomes dangerous for living beings[14].

Floodplains

The periodic flooding of land between river channels and river sides is a common feature of lower reaches of rivers throughout world. This produces a complex variety of riverside wetlands, depending on the climate, the water regime and the form of the floodplain. The natural lay of land helps in controlling depth, timing and duration of flooding. Permanent or semi permanent areas of standing water may be left after the recession of floodwater in the form of oxbows and other depressions. These are important wildlife habitat and a key resource for many subsistence farming communities. According to varying amount of rainfall, which varies throughout the world, floodplain wetlands retain water from few months to throughout the year. These wetlands are also extremely rich in their faunal diversity, and are extensively used by migratory waterfowl.

Man-made wetlands

There are also numerous wetland habitats or those that have developed in areas influenced by human activities. Such as seepage of water from reservoirs or spill-over from irrigation channels create substantial waterlogged areas which support wetland vegetation. Manmade wetlands include reservoirs, ponds and lagoons, extraction pits and waterways. Many of them are close to dense concentration of population, which increases their educational, scientific and recreational values. Numerous village tanks and small

irrigation reservoirs harbour a variety of aquatic vegetation, and also attract waterfowl in abundance. These are also often treated as wetlands.

1.4 FUNCTIONS AND ASSOCIATED VALUE OF WETLANDS

Every ecosystem whether macro or micro system, performs certain functions, and has lot of value in terms of production. These functions are ecological attributes of an ecosystem that are the results of interactions among its physical, chemical and biological components. Production of organic matter from carbon dioxide, water and various nutrients by the plants during photosynthesis is a basic function of all ecosystems. Next function is to transfer this plant food to different trophic levels that results in secondary production. During the process, various nutrient elements also pass and are consumed which were earlier absorbed by plants from soils. This cycling of various elements is another important function of ecosystems.

Similarly, value is also an important aspect of an ecosystem. 'Value' is a human judged economic concept which depends upon the perception of utility of something. The goods and services provided by an ecosystem are considered as values. All values are derived from the functions performed by an ecosystem. The primary production function has a value if the organic matter is utilizable as food, fuel, fodder, fiber and timber or otherwise.

All wetlands perform certain functions and hence, have some values. These functions can be classified into three parts: (fig.1.2)

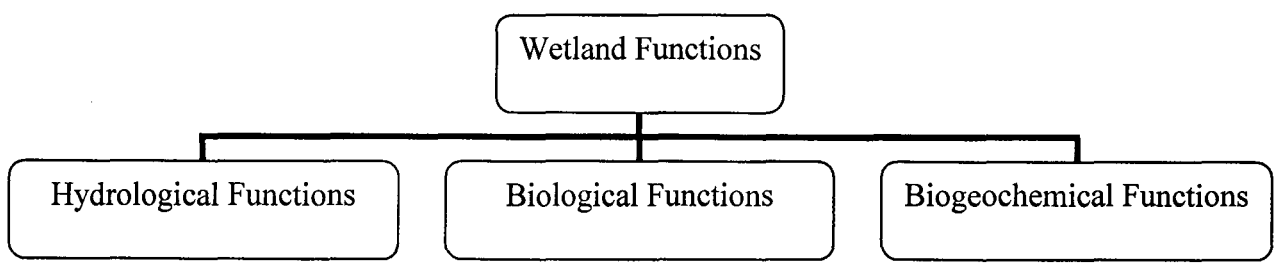

Fig.1.2

A lot of other micro functions are also completed by fragile ecosystems of wetlands along with above mentioned macro functions which bestow upon wetlands their different values. These are as follow:

Floodwater Storage

Floodplain wetlands are particularly valuable in flood regulation as these hold water for varying periods, release it later gradually, and thus moderate the peak discharge. These may be in the form of meanders and oxbow lakes. Coastal wetlands in the form of lagoons and backwaters also help in mitigating the effects of flooding by tides.

Groundwater Recharge

Wetlands play important role in the recharge of groundwater aquifers. This depends on the characteristics of surface geology and soils in the wetland. Alluvial soils with lower clay content are likely to favour recharge. Water extracted from aquifers can be used for human consumption or agricultural use.

Source of water

Sometimes wetlands are important sources of water for the use of both humans and animals. Like oases are the types of wetlands which are the only sources of water in deserts and semi arid regions.

Silt Trapping

Wetlands are banks where a big part of sediments are deposited in the form of silt and debris. These sediments often have a direct economic value. This sediment is used for making new roads and bricks.

Habitat for Wildlife

Wetlands are important habitats for many plants and animals. Many of them are endangered or threatened species whose survival rests entirely on wetlands. One-horned Rhino and Brow Antler Deer in India, Heritiera Minor in Indian mangroves (Sunderbans), Siberian crane, marsh deer, Proboscis monkey, Leaf monkey and Green turtle are the rare species which get supportive ecosystem and habitat in wetlands[15].

Storm Abatement and Control of Erosion

Dense growth of vegetation in wetlands helps in dissipating erosive forces associated with waves, currents and water-level fluctuations. Extensive mangroves with their stilt roots greatly reduce damage caused by storms and tidal waves.

Regulation of Water Quality

Wetland food chains support further direct or indirect use of nutrients. The litter accumulating in wetlands under certain hydrological conditions acts as a sink for nutrients and toxic organic substances[16]. Wetland vegetation helps in trapping of silt.

Thus, wetlands help improve water quality in adjacent water bodies and downstream regions, acting as a filter of waters passing through them[17]. Thus, wetlands need to be called ***'Kidneys'*** of nature. This value is true for wetlands which are connected with open water systems. In the absence of outflow of water from other wetlands, water quality is rapidly degraded.

Global cycling of gases

Wetlands significantly influence the global cycles of major elements, particularly carbon, nitrogen and sulphur[18]. In wetlands such as peatbogs, the organic matter does not decay but accumulates over very long periods. Wetlands may contribute to the global reduction in carbon dioxide levels or to its addition if the peat is drained. Similarly, denitrification from wetlands is an important step in balancing the global nitrogen budget. Wetlands are responsible for considerable nitrogen fixation by *blue green algae.*

Apart from the above, wetland plants are highly productive in water logged conditions that would damage or kill the roots of other plants. Many have specialized tissue or organs through which oxygen can be moved quickly to the roots. Many have large leaf areas and little wood or thickened tissue, meaning that more of a wetland plant is devoted to photosynthesis – to create growth and energy – than in many other land plants. Some wetland plants have physiological adaptations, such as the ability to stimulate alcoholic fermentation in roots to provide energy, at the same time avoiding alcoholic poisoning.

Socio-cultural, aesthetic and recreational values

Wetlands provide people – directly and indirectly – with an enormous range of goods and services; staple food plants, fertile grazing land, support for inland and coastal fisheries, flood control, breeding grounds for waterfowl and fuel from peat, among others. Many of these products are a direct result of the extraordinary vegetation productivity of wetland communities.

These direct products include firewood for fuel, timber and wood for furniture, fiber for textiles and tanning material for leather. Besides, wetlands also generate material for food, drugs and beverages such as sugar, alcohol, cooking oil and medicine etc. These also provide material for agriculture and industry like fodder, green manure and raw material for paper making.

Apart from these, wetlands provide indirect products normally include fish, prawns, honey from bees and many other products from birds and mammals inhabiting these wetlands. Power boating, canoeing, fishing, collecting mollusks and crustaceans, hunting, hiking, picnicking, swimming and snorkeling, bird watching, wildlife observation, photography and nature education are some recreational uses of wetlands.

1.5 WETLAND LOSS AND DEGRADATION

It has been estimated that of every minute one hectare of wetlands is getting drained or degraded all over the world. There are five main causes of loss or degradation of wetlands.

- Loss of wetland area
- Changes in water quality
- Changes in water regime
- Over exploitation of wetland products and
- Introductions of endangered or alien species.

Wetlands are facing problems due to increasing population in the catchment area, urbanization and industrialization and various other human activities. These account for the over exploitation and lead to degradation of wetlands as seen in Figure 1.3.

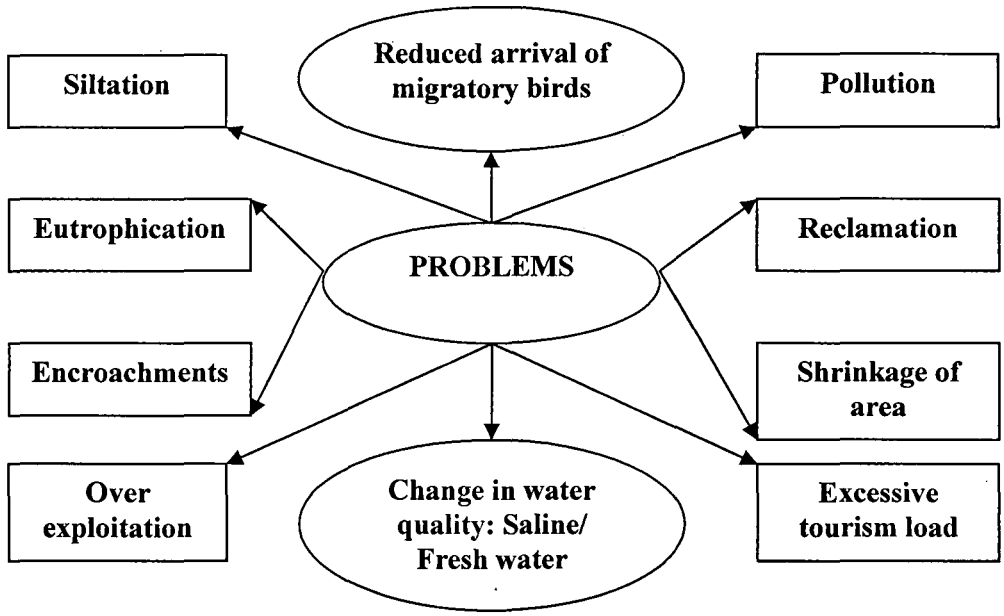

Fig. 1.3

Wetlands get threatened by excessive loading of silt and nutrients due to removal of vegetation cover in the catchment area. Vast areas of wetlands have been encroached for agricultural purposes and for settlements etc. These threats have resulted into shrinkage of area. Weed infestation and colonization by *Water Hyacinth* causes further degradation in many wetland ecosystems. Thus, there is urgent need of sustainable development and management of wetlands. As stated earlier, wetlands need to be saved as these perform a variety of functions and provide many products.

1.6 WETLANDS OF INDIA

India has unique geographical position with varied terrain and climate. It ranges from the cold arid desert of Ladakh to the warm arid desert of Rajasthan; on one hand wet humid western coast and north eastern parts. With a coast line of over 7500 km, and major river systems and lofty mountain ranges with vast plains and plateaus, no wonder India contains a wealth of wetlands. Wetlands in India have been neglected. The largest wetland regime of India is the Indo-Gangetic floodplain. These remain submerged for long time due to floods during monsoon. Rivers in north India are perennial while in south there are mainly rain fed. Most of the natural wetlands of India are connected with

the river systems. The various multi purpose projects launched to harness these river systems have also provided a number of man-made wetlands, e.g. Harike Barrage at the confluence of Beas and Sutlej in Punjab, Bakhra Nagal dam in Punjab and Himachal Pradesh, and Kosi Barrage on Bihar and Nepal border. India also has many lakes – both natural as well as man-made. It has been estimated that an area covering about 4.1 million hectares is under wetlands in India out of which 1.5 million hectares of wetland area has natural and 2.6 million hectares has man-made wetlands[19] (table 1.1).

Table 1.1

Distribution of Wetlands in India

State	Natural		Man-made	
	NO.	Area (hec.)	NO.	Area (hec.)
(1)	(2)	(3)	(4)	(5)
1. Andhra Pradesh	219	1,00,457	19,020	4,25,892
2. Arunachal Pradesh	2	20,200	NA	NA
3. Assam	1394	86,355	NA	NA
4. Bihar	62	2,24,788	33	48,607
5. Goa	3	12,360	NA	NA
6. Gujarat	22	3,94,627	57	1,29,660
7. Haryana	14	2,691	4	1,079
8. Himachal Pradesh	5	702	3	19,165
9. Jammu & Kashmir	18	7,227	NA	21,880
10. Karnataka	10	3,320	22,758	5,39,195
11. Kerala	32	24,329	2,121	2,10,579
12. Madhya Pradesh	8	324	53	1,87,818
13. Maharashtra	49	21,675	1,004	2,79,025
14. Manipur	5	26,600	NA	NA
15. Meghalaya	2	NA	NA	NA
16. Mijoram	3	36	1	1
17. Nagaland	2	210	NA	NA
18. Orissa	20	1,37,022	36	1,48,454

19. Punjab	33	17,085	6	5,391
20. Rajasthan	9	14,027	85	1,00,217
21. Sikkim	42	1,101	2	3
22. Tamil Nadu	31	58,068	26,030	2,01,132
23. Tripura	3	575	1	4,833
24. Uttar Pradesh	125	12,832	28	2,12,470
25. West Bengal	54	2,91,963	9	52,564
Total	2,167	14,58,574	65,251	25,87,965
Union Territories				
1. Chandigarh			1	170
2. Pondicherry	3	1,533	2	1,131
Total	3	1,533	65,254	1,301
Grand Total	2,175	14,60,107		25,89,266

***Source:* Wetlands of India, a Directory by Ministry of Environment and Forest, GOI, 1990**

Note: Data for Jharkhand, Uttaranchal and Chhattisgarh states are included with their earlier states.

India also has mangroves covering an area of 6740 sq. km area. The major concentration of mangroves in India is *Suderbans* and *Andman & Nikobar* islands which hold 80 per cent of mangroves of the country. The deteriorating conditions of wetland in the country show that neither government nor society is paying proper attention towards the management and sustainable conservation of these precious ecosystems of wetlands.

The threats to the wetland ecosystem in India can be classified under two broad heads – 'Natural and Human'. The natural threats are subsidence, cyclones, siltation and shifting of river mouth etc. Human threats come from over exploitation, encroachment, reclamation for agricultural and other purposes. The worst is pollution from human habitation, the industrial effluents and nutrient load leading to weed growth.

The great Wullar lake of Jammu & Kashmir has now been reduced to $1/3^{rd}$ of its original size due to siltation and encroachment. Chilka is among the largest brackish water lagoons in South-East Asia. Its mouth has become silted to such an extent that there is no access of sea water. Consequently, the entire ecosystem is undergoing a change.

Another problem is the growth of weeds – floating and submerged. The examples are *Salvina, Eichornia, Typha* etc. The worst is *Water Hyacinth* or *Eichornia.* It is of American origin and has occupied a big part of many Indian wetlands like Harike and Keoladeo National Park wetland and others. The sheer mass of this weedand its capacity for multiplication has become a challenge to environmentalists[20].

Realizing the crucial role of the wetland ecosystems, the Government of India has recently started taking steps for their conservation and management. A National Wetland Committee was set up on 24th March, 1987 consisting of experts from different disciplines for advising the Government on the selection of sites and drawing up conservation strategies. International collaboration has an important role in wetland conservation since it enables sharing of knowledge and experience of other countries. India is a member of RAMSAR Convention. Initially six wetlands were designated for these purposes by RAMSAR, which are

1. Keoladeo National Park, Bharatpur, Rajasthan
2. Chilka, Orissa
3. Harike, Punjab
4. Wullar, J&K
5. Sambhar, Rajasthan and
6. Bhoj, Madhya Pradesh.

Government of India has recently made an important plan to conserve and manage wetlands and to promote tourism in these. These have been selected from different states of country according to their capacity to convert available potentials of conservation and sustainable utilization. These are following (table 1.2):

Table 1.2

Wetlands Selected for Conservation and Management

Name of wetland	State
Kolleru	Andhra Pradesh
Wullar & Tso Morari	Jammu and Kashmir
Chilka	Orissa

Loktak	Manipur
Bhoj	Madhya Pradesh
Keoladeo National Park, Sambhar, Pichola	Rajasthan
Sasthamkotta and Ashtamudi	Kerala
Nalasarovar	Gujarat
Harike and Roper	Punjab
Ujini	Maharashtra
Renuka, Pongdam and Chandratal	Himachal Pradesh
Khabar	Bihar
East Calcutta Wetland	West Bengal
Sukhna	Chandigarh
Deepar beel	assam

Source: Annual Report. 95 – 96, Ministry of Environment and Forest, GOI

1.7 REVIEW OF THE LITERATURE

Utilization and management of wetlands have not been given adequate attention in studies. Wetlands are among most productive and threatened ecosystems. The marshes, swamps and floodplains have been important since the emergence of great civilizations at the banks of rivers and have been supporting rural communities in many parts of world. But presently, these are getting degraded due to blocked drainage, over exploitation and pollution and many of these have already been lost. We must not only harvest their natural production, but also examine their potential for agriculture and aquaculture. It is only after 'Ramsar Convention' in 1971 (Iran) that researchers started taking interest in this matter.

It has been mentioned that socio-economic and physical conditions and processes of change in the wetland regions (areas) of both temperate and tropical countries are different. Keeping this in mind, it becomes essential to have a look at the studies related to these processes operating in the wetlands of temperate and tropical countries. Equally important is to see the studies conducted on Keoladeo National Park – the main concern of the present study.

In India, first serious attempt was made by 'Rai and Dutta Munshi' (1992) by studying ecological characteristics of 'wetlands' or 'chaurs' of north Bihar. The State Forest Department has done basic studies of lake ecosystem (khabar taal) whereas detailed socio-economic survey has been carried out by Mishra and Negi (1985). Shahi (1982) and the Forest Department have been successful in counting the number of birds caught from wetlands by hunters and bird-catchers. The Bombay Natural History Society started an environmental survey program which also included 'bird ringing programme.

According to Brij Gopal (1982), so little is known about the nature, extent, status, structure and functions of wetland ecosystems that the approach for conservation appears nonexistent. Our knowledge is very limited about proper assessment of wetland utilization and management.

Again Brij Gopal (1989) proceeded on the assumption that no wetland management can succeed by keeping the people away because traditional societies have always lived closely knit with these habitats. Taking the Keoladeo National Park wetland and Kolleru lake as case studies, he concludes that the real management can be done only with the help of local people.

But Dr. Maltby (1986) argues that we should approach the questions related to the problems of wetlands in a way which takes account of the complexities and values of the ecosystems which we seek to exploit. Development should take account of the ecological structure of these systems so that we continue to reap benefits from these on a sustainable basis.

An attempt has been made by Saxena (1990) to detail out characteristics of wetlands and their usefulness; so that their management is justified even on technical and economic grounds. According to him, unfortunately we are biologically less literate generation. We have to create awareness that we and other living beings are fellow travelers on this planet. Tomorrow may be too late. We should act fast now.

Mahajan (1990), in his introductory paper tried to give a concise definition of wetlands. The definition is extended to other confined water sources such as lakes and reservoirs; natural as well as man made, for practical purposes to have a judicious management plan based on ecologically sound principles for all the confined surface waters as natural resource. The paper further elaborates the significances and the

importance of wetlands as important ecosystems – economically, ecologically, as well as biologically.

Besseling (1989) describes the perspective of wetland management under changing conditions both of environment as well as changing views of government. The example of the Krammer–Volkerak Lake, a subsystem of the Dutch delta area makes it clear that after completing water works, new natural values can be developed. The role of Government is significant in this case.

Work done by Dugan and Patrick (1988) provides an approach towards the importance of rural communities in wetland conservation and development all over world. They emphasis on the realization of importance of wetlands like 'Clean Water Act' in USA. Although an understanding of goods and services provided by wetlands of developed world is far from adequate, that for developing world is minimal. Same examples of direct use of natural tropical wetlands by human society are also cited like – Inner delta of River Niger, Zambia Mangroves, Lakes etc. These examples demonstrate that throughout the developing world, rural communities currently obtain a wide range of benefits from different wetland ecosystems. Accordingly, high conservation priority is a must to maintain these values. They also suggest a five point argument that should be promoted by wetland conservation communities.

Henri Roggeri (1995) has done study related to the sustainable management of tropical fresh water wetlands. His work is primarily intended for all those involved in the provincial planning and management of development and nature conservation projects in regions where fresh water wetlands occur. He mainly focuses on fresh water wetlands occurring in developing countries i.e. African, Caribbean & Pacific countries (associated with European Union). It mainly –

- Systematically presents current knowledge acquired from wetland projects and relevant researches.
- Provides guiding principles and practical approach on the basis of current experience.
- Indicates sources of information and expertise relevant to tropical wetlands and their management.

Another relevant work has been done by John F. Richards (1990). His work characterizes the impacts of agriculture especially of paddy cultivation on coastal wetlands of south and south-east Asian countries. He has taken the examples of Ganges-Brahamaputra delta, the Irrawaddy and Chao Phraya of Thailand. He found out the changes in the landuse during hundred years from 1880 to 1980, when these countries were British colonies. According to him, wet rice lands in these deltas grew by an estimated 200 per cent over the century. His worry is that the conversion of these precious wetlands into rice fields is blindly going on. He has also suggested a model for rice farmers. He says that if farmers adopt more sophisticated arboriculture and aquaculture then rice culture becomes sustainable in long term. They can boast of a sophisticated dike-pond system that produces rice, mulberry, carp, pigs, sugarcane, soyabeans, peanuts and fruits in a complex interlocking system. This model is being used in *Zhuziang delta* without deteriorate the wetlands of the region.

Famous ornithologist of India, Dr. Salim Ali's (1980-85) contribution for birds and wetlands is must not be forgotten. He was the first person who made a serious attempt to study and fetch out a lot of analytical results in Keoladeo National Park wetland. He studied the physical environment, limnology, vegetation, aquatic invertebrates and terrestrial arthropods, fish fauna, ornithology and mammals found in KNP wetland ecosystem over a period of six years. Analyzing the whole ecological and social process of the wetland, he has discussed the major management problems of which some are environmental and others are social. He has made a few recommendations for sustainable development of the wetland.

Some socio-economic, biological and zoological studies have been done by the Bombay Natural History Society in the endangered ecosystem of Keoladeo National Park (KNP) wetland. V.S. Vijayan (1991) spent eight years in KNP wetland to study climate and land and to find out the faults in management of the area. He concludes that both unpredictable monsoonal rains as well as the inappropriate strategies adopted by the Government are responsible for the deteriorating conditions of the wetland. He recommended an Integrated Development Programme (IDP) to the Government in which an overall development of the area is visualized with the management of the park. The IDP has the major proposal of bringing water from Chambal River to KNP.

Dr. Lalitha Vijayan (1994)37 heading the team of WORLD WIDE FUND FOR NATURE, INDIA (WWF) studied the natural depression of Keoladeo wetland which was later converted into a man made wetland. She along with her team undertook the study of physico-chemical elements of environment, biodiversity and all the ecological, economical, aesthetic and cultural values of the wetland in a collective manner. She also found out some specific threats to the fragile ecosystem of the wetland.

Ahmad and Singh (1990) and Rai (1990) studied fluvial characteristics with reference to the environment of Khabar taal. Central Environment and Forest Ministry, scientists of Geological Survey of India and Fresh Water Biological Station, Hyderabad have started working on bio fluvial studies of wetlands. Bhatia (1982) has completed ecological study of Loktak Lake.

Yadav and Varshneya (1982) carried out study pertaining to ecological and socio-economic importance of Loktak Lake. Singh (1989) has done research from the point of view of management of fishery, wild life and environment of wetland ecosystem. Trishal (1977), did a 'study of primary production in Kashmir Lake'. He has assessed biological and vegetation production. Pradhan (1989) in his study has stressed upon the need of expectation for communal participation for development and conservation of wetlands.

1.8 STUDY AREA

Keoladeo National Park (KNP) is a good example of a wetland as it provides not only nesting place to migratory birds coming from Siberia but also has rich bio-diversity. The wetland is a habitat of about 370 bird species, 27 species of fauna and 43 fish species and a variety of other wild life and plant species. KNP is one of the first two wetlands of India along with Chilka lake in Orissa which have been designated as Ramsar Sites. It is also a tourist paradise and has been declared a 'World Heritage' by UNESCO.

Keoladeo National Park lies in Bharatpur district on the eastern most side of Rajasthan. It covers an area of approximately 29 sq km and extends from 27° 7′ 36″ to 27° 12′ 12″ N and 77° 29′ 30″ to 77° 33′ E. It lies 2 km southeast of Bharatpur town. Bharatpur town is 180 km south of New Delhi, 171 km east of Jaipur and 55 km west of Agra. Initially a natural depression, it got flooded after 'Ajan Dam' situated to its west

was constructed by Maharaja Surajmal, the then ruler of the princely state of Bharatpur, at the confluence of two rivers – Gambhir and Banaganga.

Gambhir river originates in Karoli district and is the main source of water for Keoladeo through Ajan dam. Its inundation resulted into the emergence of a lot of aquatic flora and fauna which started attracting a large number of migratory birds. It is a man made wetland and has been divided into 15 (A-O) blocks by earthen dykes. The boundary of the park is demarcated by a masonry wall and is surrounded by eighteen villages. Although grazing of domestic cattle is banned but the villagers are allowed to collect fodder from the park during April – June.

The climate of Bharatpur is semi arid, and it experiences climatic extremes from a hot dry summer to a cold winter and a short monsoon. Flora of Bharatpur consists of a mixture of xerophytic and semi xerophytic vegetation.

Some studies suggest Keoladeo to be an 'Oxbow Lake' created by river Yamuna which later shifted its course[21]. Though this area has a potential for fast economic and tourism development, yet its full potentials have not been achieved.

1.9 OBJECTIVES

Every meaning full study needs to have some aims and objectives. These help in guiding the research in a right direction. The main concern of the study is to know factors affecting the study area, related problems and their solutions.

Keeping above in mind, the present study has following objectives:-

- Evaluation of Keoladeo National Park wetland in terms of physical-chemical characteristics of lake water and flora and fauna.
- Changes affecting the area since last two decades.
- Assessment of degradation of Keoladeo wetland if any and its social causes.
- Suggesting possible conservative methods for the sustainable development and management of this ecosystem.

1.10 DATA BASE

Accessibility to information in terms of quantitative data or other data is important for any scientific research. The literature review shows availability of research material on the relatively isolated areas like Keoladeo wetland is scanty. Keeping the objectives in mind, a lot of information is needed for analysis. The study has made use of mainly secondary data sources. The following are main sources of data:

- Topographical sheets no. 54 E/8 and 54 E/12 published by Survey of India on the scale 1:50000.
- Data of rainfall and temperature from Meteorological Department.
- Statistical Abstracts and Census Handbooks to provide socio-economic and demographic information concerning the area.
- Water quality data published by Salim Ali Centre for Ornithology and Natural History, Coimbatore.
- Data of water supply to Keoladeo wetland from District Irrigation Department.
- Data of 'Ornithology' of KNP from the World Wide Fund, India.
- Ground water data of study area from State Geological and Ground Water Department.
- Various unpublished and published research works, including theses, dissertations and articles, from different journals, magazines and newspapers related to study area, research theme and methodology

1.11 METHODOLOGY

Data analysis is a necessary step for deriving required information from the data set. Trend analysis of climatic phenomena particularly rainfall (1960-2004) and temperature of January (1981-2005) has been done to analyze physical changes that have taken place in the area. Variations in the physical-chemical characteristics of the wetland in terms of pH value, water depth, dissolved oxygen concentration, total alkalinity etc. have been investigated for a period from 2001 to 2004 to get an understanding of changing water quality. Temporal study of immigration of the Siberian cranes was also done on yearly basis from 1964-65 to 2004-05. Comparative analysis of this data with

climatic data has been carried out to evolve a relationship between the two. Demographic structure of the surrounding villages has been studied using census data.

Base map of the study area was prepared using Survey of India topographical sheets on 1:50000 scale. GIS techniques are applied to depict the shrinkage in wetland area. Thematic maps for location, habitat, bio-diversity etc. were prepared using published maps of the area by different government and non-government agencies.

1.12 ORGANISATION OF THE STUDY

It is important to take note of all of basic information about the theme of the study work. It gives an idea of the research in a proper way. Review of related studies having similar ecological/ environmental and human specificities is important in order to assess the gravity of the problems. An introduction of the study area in terms of expansion, climate, terrain etc. helps in setting the objectives and raising the research problems. The study deals with these problems and objectives which lead the research to some results. Apart from that, classification, types, utility and potentials of wetlands and the status of wetlands in India are necessary and relevant topics to precede the study. This has relevance while formulated in a proper theoretical frame work. The data and published evidences taken from other studies are required to support the theoretical frame work, fulfill the objectives and meet the research problems. Certain methods and schemes are needed to analyze various observations. First chapter in the form of introduction corresponds with these basic components of the study.

Introduction makes it clear that the theme of present study is to highlight the process of conservative utilization and prevention of fragile ecosystems of wetlands. Evolution of wetland in the study area is necessary to approach the present situation of Keoladeo National Park. It becomes important to know the environmental and ecological specificities of the area. It is important to understand the physical characteristics of the wetland. Thus, these components have been put in second chapter entitled **'Keoladeo and Its Environment'.**

The conservation and process of sustainable development are related to the various problems found in the study area. Therefore specific problems need to be identified to find their resolution. Potentials of the wetland are referred to in terms of

utilization. Thus, the ecological and human related problems and potentials have been discussed in third chapter entitled **'Problems and Potentials of Keoladeo National Park'.**

The major eco-destructive and money fetching activities in the various wetlands of India such as Keoladeo wetland are due to over-exploitation of local environmental resources. This requires study of the dynamics of direct and indirect interface between human beings on one side and economically useful natural resources in the form of wetlands on the other. So, the monitoring and evaluation of Keoladeo wetland with the various interlinkages between population and fragile ecosystem of wetland have been presented in the fourth chapter entitled **'Impact of Human Interference on Keoladeo Wetland'.**

The increasing physical needs of growing population exert more pressure on the limited economic and natural resources, and wetlands are one of these important resources. The depletion and deterioration of wetland ecosystem is hazardous not only to the living organisms of this ecosystem but for human beings also. Human beings have to face many problems but have only a few economic alternatives. Thus, it is necessary to comprehend the living conditions and environmental problems as well as to evaluate the conservation, utilization and management of wetlands. These issues have been taken up in fifth chapter as **'Major Management Issues in Keoladeo National Park'.** Finally a summary of conclusions has been presented in the last chapter.

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Chapter 2

KEOLADEO AND ITS ENVIRONMENT

An investigation into the historical and geographical perspectives helps to get detailed information about man and environment interaction in any area. It also lays foundation for developing a sustainable approach towards conservation and management of the area. In the process, it explores into the inherent problems of the area too. On the other hand, it provides both implicit and explicit linkages to the problems prevailing in the area.

To start with the study of Keoladeo National Park, it is important to make an inquiry into the history and evolution. It helps to understand how the ecosystem got modified with time. Geographical aspects like physiography, climate, drainage etc. provide knowledge about the environmental constraints those must not be overlooked wile making planning strategies. Flora and fauna, which form an integral part of the ecosystem, also need to be studied. These take part in the functioning of the ecological cycle. While studying the lake ecosystem, it is important to examine the physical and chemical characteristics of the lake in terms of water depth, water and atmospheric temperature, pH value of water, dissolved oxygen, total alkalinity etc. These features have been studied with reference to Keoladeo wetland. These include:

a) Evolution to know about the man-environment interaction that has taken place in the area.
b) Physiography relates to the spatial and terrain analysis
c) Drainage and ground water explain water supply prospects in the area
d) Climate is an important agent in modifying the ecosystem of the area.
e) Physical and chemical characteristics of lake water to understand degradation in water quality over time.
f) Flora and fauna to know bio-diversity.

2.1 EVOLUTION

The evolution of the natural depression of Keoladeo wetland has been highlighted in several studies conducted at different points of time. Keoladeo has been shown to be a natural depression left by Yamuna river[1]. The Yamuna used to flow near Bharatpur about three hundred years back and it gradually shifted its course towards Mathura in U.P[2]. As

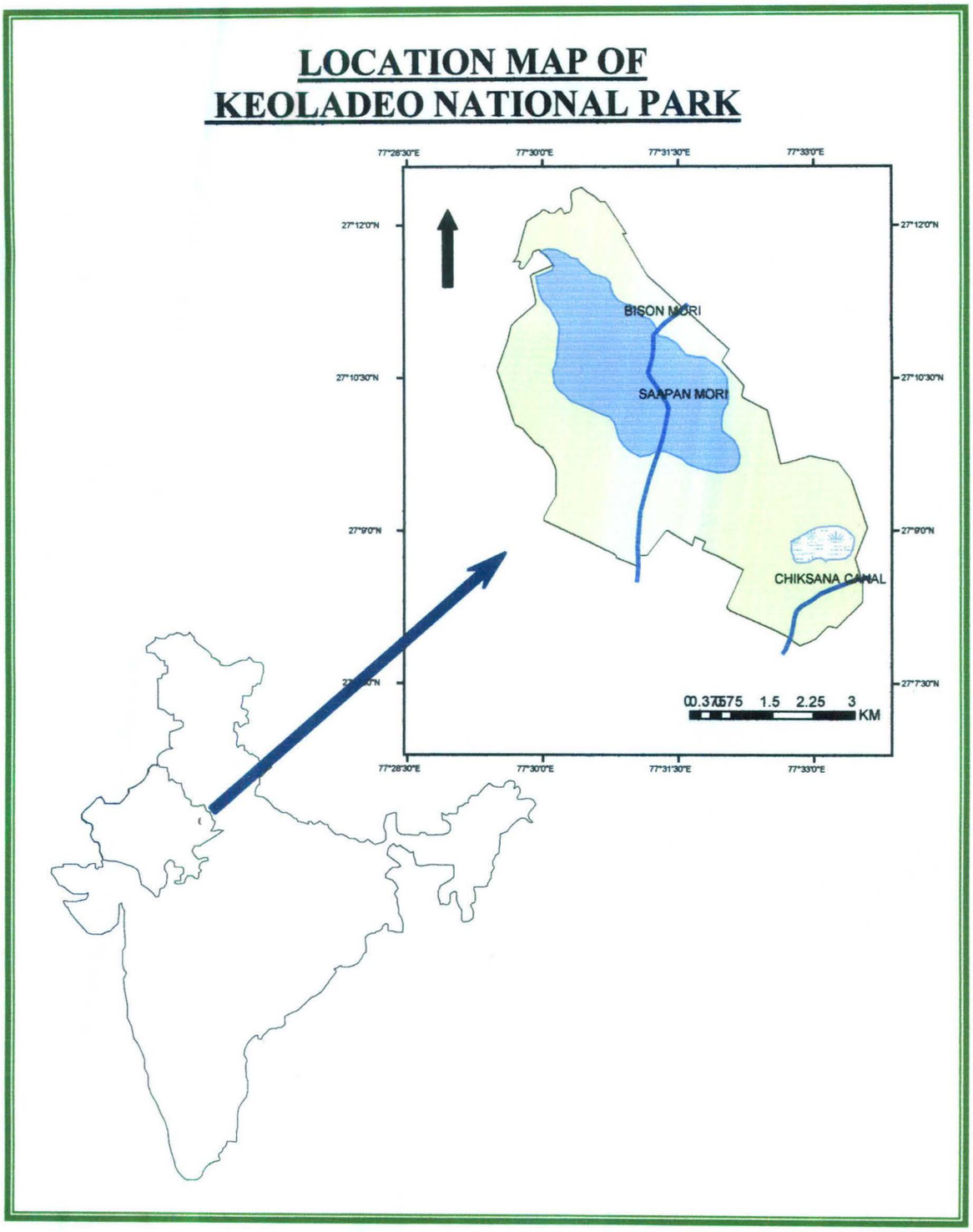
LOCATION MAP OF
KEOLADEO NATIONAL PARK
77°28'30"E
77°30'0"E
77°31'30"E
77°33'0"E
27°12'0"N
27°10'30"N
27°9'0"N
27°7'30"N
BISON MORI
SAPAN MORI
CHIKSANA CANAL
0 0.375 1.5 2.25 3
KM

Fig. 2.1

a result of changing its course, Yamuna created this natural depression which later got filled with water from rainfall and canal from Ajan Dam.

The presence of Kadamb (*Mitragyna parvifolia*) groves, believed to be the climax vegetation of a swamp or river-bed, probably show existence of Keoladeo wetland since centuries ago[3]. Keoladeo Lake was modified considerably in the 18th century by regulating water from the rivers Banganga and Gambhir through a system of canals and dykes. These were built for flood control and irrigation purposes[4].

The present National Park appears to have had its beginning some time between 1726 and 1763 when the Ajan bund was constructed by Maharaja Surajmal, the then ruler of the princely state of Bharatpur. The dam was built at the confluence of the two rivers namely Gambhir and Banganga[5,6]. Ajan bund having 3270 hectares impoundment located about a kilometer east of Keoladeo, supplies water via Ghana canal which passes through the Park to Jatoli village lying on its periphery.

The Ajan and other dams in the region provide enough moisture for raising crops for a year even after the water is drained or gets evaporated. It is a method which constitutes the traditional system of inundation irrigation. The dykes dividing Keoladeo wetland into different compartments are also believed to have been built in the 1700s[7]. Past records show the presence of these dykes.

The fact is also mentioned that Keoladeo National Park was earlier called '*Ghana*' during princely rule times and later came to be known as Ghana Bird Sanctuary after independence. It got this name because of its dense vegetation. But there is a strange and less known fact recorded in the *'Gazetteer of Rajputhana'* about the area and location of Ghana (Keoladeo). According to the gazetteer, there were two forest areas around Bharatpur town in times of princely rule – Ghana no. 1 and Ghana no. 2. The latter was situated near village known as Kanjoli. Presently, there is a small lake with scattered trees and grassland named *Moti Jheel* which probably is a remnant of Ghana no. 2. Most of the area has been converted either into cultivated land or into human settlements. While Ghana no. 1 has been preserved in the form of Keoladeo National Park.

Inundation of this natural depression resulted into the growth of lot of aquatic vegetation, which started attracting large number of migratory birds. The marshes of Bharatpur soon developed into a duck shooting reserve and was formally inaugurated for

this purpose in 1902 by Lord Curzon, the then Viceroy of India. A shooting party headed by Lord Linlithgow, the then Viceroy of India shot 4,273 birds on 12th November, 1938 (Plate 1). This has been inscribed on a pillar near Keoladeo temple in the Park (Plate 2).

The rainfed wetland was converted into a permanent waterfowl shelter mainly for the following reasons:

- Making a waterfowl refuge in order to provide royal guests with game hunting,
- Providing grazing facilities for the village cattle,
- Preventing cows and ungulates from raiding the village crops, and
- For protecting Bharatpur town from the deluges which occurred often in those days.

The first conservation measure carried out in the area was in the form of fencing around the forest. This fencing was done towards the end of the 19th century to check cattle from raiding nearby croplands[8]. The first Forest Act of Bharatpur was passed in 1925, and erstwhile 'Shikaar Department' was brought under the Forest Department. Subsequently, nurseries and plantations were taken up in the area[9]. A working plan, prepared for 1944–1964, prescribed plantations of *Acacia nilotica* on the banks and dykes in Keoladeo and also for other areas of Rajasthan[10].

After a strong recommendation of The National Committee of India for Bird Preservation, Keoladeo 'Ghana' was notified as a bird sanctuary by the Indian Government in 1956. Ruler of Bharatpur continued to have control over the area. Hunting rights remained with the Maharaja of Bharatpur. His guests continued to hunt till 1965 which resulted in the loss of many birds and animals. Local villagers were sending their cattle to graze in the park till 1970s. The Prime Minister of India had to intervene after getting complaints from the Park officials. Consequently, a masonry boundary wall was built around the Park between 1977 and 1981.

Keoladeo Ghana was declared a RAMSAR SITE and was upgraded to National Park in 1981. The park was declared a **World Heritage Site** under the World Heritage Convention in 1985. Under Ramsar Convention a treaty was signed which provides the

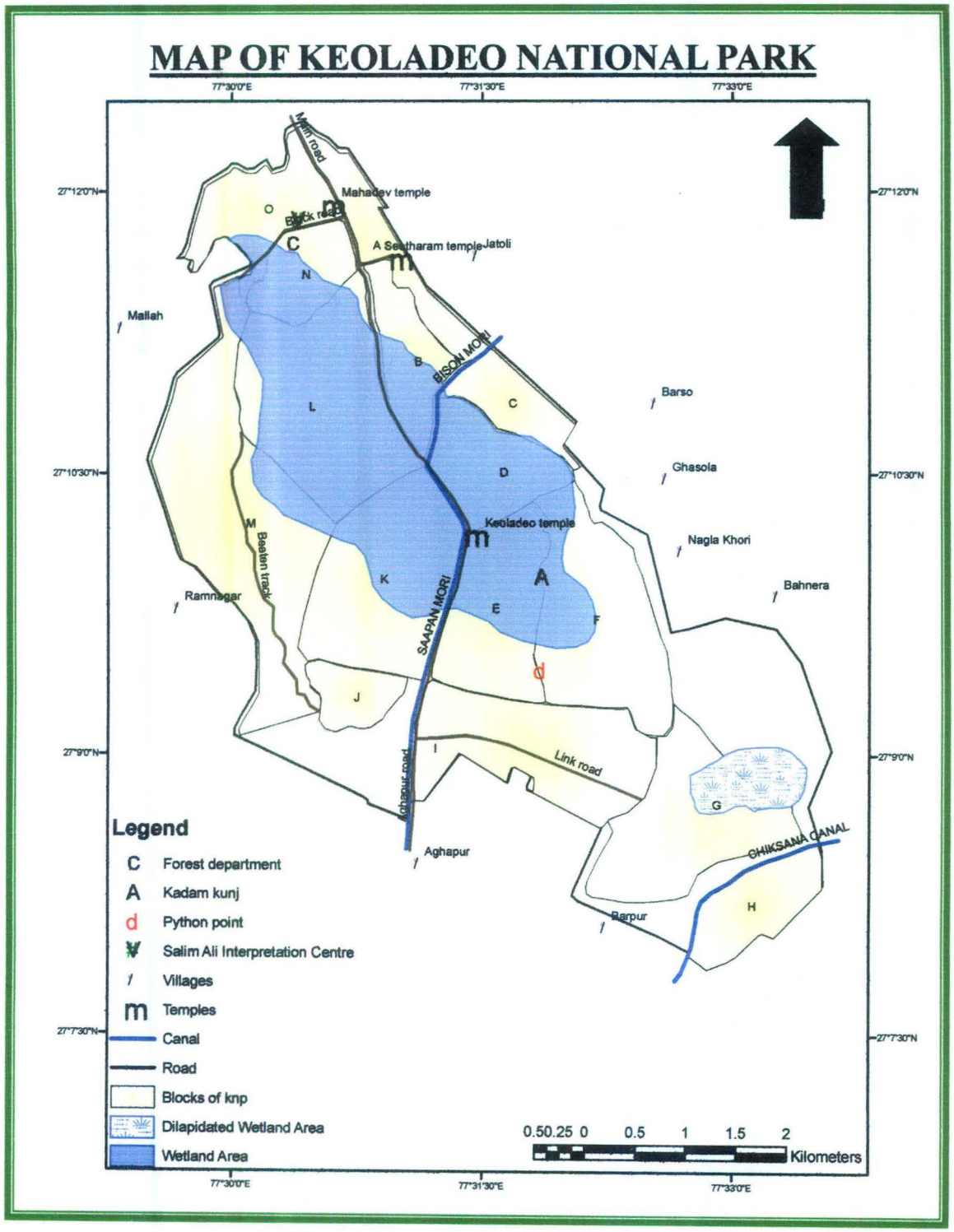
MAP OF KEOLADEO NATIONAL PARK
77°30'0"E
77°31'30"E
77°33'0"E
27°12'0"N
27°10'30"N
27°9'0"N
27°7'30"N
Main road
Mahadev temple
Brick road
A Seetharam temple
Jatoli
Mallah
BISON MORI
Barso
Ghasola
Keoladeo temple
Nagla Khori
Bahnera
Ramnagar
Beaten track
SAAPAN MORI
Aghapur road
Link road
Aghapur
CHIKSANA CANAL
Barpur
Legend
Forest department
Kadam kunj
Python point
Salim Ali Interpretation Centre
Villages
Temples
Canal
Road
Blocks of knp
Dilapidated Wetland Area
Wetland Area
0.50.25 0 0.5 1 1.5 2
Kilometers

Fig. 2.2

framework for international cooperation for the conservation of wetland habitats. Although the text of the convention was adopted in 1971 at the Iranian city of Ramsar, but the Convention came into effect only in late 1975. Now, it has signatory parties throughout the world, including India which acceded to the Convention in 1982.

Wetlands are selected from the List of Sites on account of their international importance. This importance is established on the basis of ecological, botanical, zoological, limnological, or hydrological criteria. The signatory parties have special obligation towards the conservation of the listed sites, by taking appropriate measures to preserve their ecological characteristics. Presently, along with Keoladeo National Park, there are eighteen other Ramsar sites in India. Keoladeo wetland (Rajasthan), Chilka Lake (Orissa), Sambhar Lake (Rajasthan), Wular Lake (Kashmir), Bhoj wetland (Madhya Pradesh) and Harike Lake (Punjab) have been designated as wetlands of International importance.

2.2 PHYSIOGRAPHY

Keoladeo National Park occupies location extending from 27° 7′ 36″ to 27° 12′ 12″ N and 77° 29′ 30″ to 77° 33′ E longitudes. It is situated on the western most edge of the Gangetic basin, three kilometers southeast of Bharatpur town, and is well connected by road and rail. The boundary of the park is demarcated by a masonry wall. The park is surrounded by 21 villages.

The Park covers an area of approximately 29 sq kms. Topography is almost flat with elevation varying from 170 to 176 m. It has a gentle slope towards the central depression. Total area of the depression is about 8.5 sq kms. This is the main submergence area of the wetland. This submergence area has been divided into various unequal compartments by earthen dykes. Sluice gates have been built at strategic locations of these dykes to regulate water supply to the park. The bottom of the compartments is generally flat except a narrow stretch alongside each dyke. Area is deeper in these stretches for removal of mud for constructing dykes and mounds. Occasionally some ditches of varying sizes develop in rest of the area.

Soil of the area is similar to that found in the middle and western parts of Uttar Pradesh. This is in the form of thick alluvium with little sand. Patches of saline soil are a common sight in the area.

Bharatpur is the nearest town and is the headquarter of the district of the same name. It had a population of 3,72,876 persons in 2001. The number of villages around the park has increased over the years. The most populated village is *Malaah* with a population of 5183 persons in 2001. People of the village used to catch fish and row boats in the lake during the time of princely state. They were called '*Mallahs*' in local language so the village acquired the name *Malaah*. Frequent droughts have lowered the water table considerably leading to changes in the cropping pattern from food crop towards oil seeds.

Keoladeo National Park can be divided into two parts – Wetland and Dryland. The dryland also has forest patches. 11 sq kms area of the park is under the lake or is water logged which constitutes wetland. The rest 18 sq kms is a dry land which partially becomes a part of the wetland during flood or inundation. It gets a grass cover with scattered patches of trees when water recedes. After it was declared a bird sanctuary, to conserve and manage the wetland, the administration divided it into 15 Blocks numbering A to O.

2.3 DRAINAGE AND GROUND WATER

Flora and fauna in the ecosystem of Keoladeo wetland depends on water availability through various big and small sources. Simply it can be said that the source of water, its quantity and quality are major factors affecting the Keoladeo wetland. Three sources of water fulfilling water requirements of the Park are rivers, canal and ground water.

Three small rivers flow in Bharatpur district. Ruparel river coming from Alwar district does not add water to Keoladeo wetland. Gambhir river flows from Karoli district and Banganga river from Jaipur. The Keoladeo wetland is situated at the confluence of Gambhir and Banganga rivers. Currently, there is no water supply to the wetland from the Banganga river because its water is diverted to Ramgarh dam to meet drinking water

requirements of Jaipur City. So the only source of water supply to Keoladeo wetland is Gambhir river.

Water from Gambhir river is brought to Ajan reservoir through Pichuna canal. The supply of water from Pichuna canal is limited. So, mostly the wetland has to depend on monsoonal rain which is unpredictable in nature.

The watershed of Gambhir river is spread in the hills of Karoli district covering Tehsils of Bayana and Roopbas (Bharatpur), Rajakhera Tahsil (Dhaulpur) and some parts of western Uttar Pradesh. The Banganga river originating at Manoharpur in Jaipur district flows through Jamuva-Ramgarh and Mekhpur settlements from where sometime water is taken to Ajan reservoir through the Uchain canal.

Water brought to Ajan reservoir is retained there for sometime to let the silt settle and is then released into the park and the surrounding villages in July and August. The reservoir nearly gets empty in the month of October and the land is put under cultivation of *Kharif* crops utilizing the available soil moisture.

Main supply canal to the park is 'Dakan Mori' which comes from Ajan bund. It runs through the park and ends at the village *Jatoli*. Every block of the park is filled upto the depth of 3 to 5 feet with water. The Park needs about 600 mcft (million cubic feet) water supply every year. The supply of water to Keoladeo wetland has always been less than required during the last 30 years. Quantity of water received from Ajan bund has varied from year to year (Table 2.1). It has highly fluctuated with time. On an average it has a decreasing trend which is more prominent in the later years. During middle of 1980s, it decreased considerably due to successive droughts during that period. In general, it has corresponded with the rainfall in the area. It increased in early 90s owing to good rainfall.

Table 2.1

Water Supply to Keoladeo Wetland from Ajan Bund

Sr. No.	Year	Quantity of water in million cubic feet	Sr. No.	Year	Quantity of water in million cubic feet
1.	1975-76	515	3.	1977-78	514
2.	1976-77	283	4.	1978-79	283
5.	1979-80	285	18.	1992-93	584
6.	1980-81	517	19.	1993-94	475
7.	1981-82	517	20.	1994-95	505
8.	1982-83	522	21.	1995-96	517
9.	1983-84	516	22.	1996-97	433
10.	1984-85	347	23.	1997-98	180
11.	1985-86	346	24.	1998-99	297
12.	1986-87	62	25.	1999-2000	344
13.	1987-88	141	26.	2000-2001	143
14.	1988-89	485	27.	2001-2002	184
15.	1989-90	197	28.	2002-2003	N.A.
16.	1990-91	470	29.	2003-2004	204
17.	1991-92	469	30.	2004-2005	18

Source: District Irrigation Department, Bharatpur (Rajasthan)

2.4 CLIMATE

Keoladeo wetland has climatic conditions similar to those existing in the eastern Rajasthan. The area has semi arid conditions. Bharatpur experiences climatic extremes from very hot and dry summer from April to June to a cold winter extending from November to January. There is a short rainy monsoon season from July to September. Keoladeo is a little cooler than rest of Bharatpur district during these seasons[11].

The temperature ranges from a minimum of 0°C to 2°C in winter to a maximum of 46°C to 48°C in summers. The southwest monsoon, which sets in towards the end of June, remains active till September with occasional light showers in October. The mean annual rainfall is 670 mm, most of which is received during the monsoon months. But it dropped to 500 mm in 1980s with recurring droughts (Table 2.2). Maximum rainfall is received during the months of July and August.

Table 2.2

Rainfall at Bharatpur Town and at Ajan Bund

Sr. No.	Year	Bharatpur Town (mm)	Ajan Bund (mm)	Sr. No.	Year	Bharatpur Town (mm)	Ajan Bund (mm)
1.	1960	684.6	579.8	24.	1983	897.2	808
2.	1961	584.5	N.A.	25.	1984	472.4	575
3.	1962	436.1	N.A.	26.	1985	194.9	207.8
4.	1963	608.3	N.A.	27.	1986	310	263
5.	1964	595.5	N.A.	28.	1987	349.8	314
6.	1965	665.9	691.7	29.	1988	545	671
7.	1966	578.6	547.7	30.	1989	515.4	438
8.	1967	750.2	660.2	31.	1990	613.4	570
9.	1968	637.4	372.2	32.	1991	448.8	420.2
10.	1969	441.8	633.6	33.	1992	574.4	506.8
11.	1970	620.8	437.7	34.	1993	507.0	433.7
12.	1971	729.6	546.1	35	1994	549.4	495.1
13.	1972	566.6	482.0	36	1995	922.6	1154
14.	1973	592.5	317.9	37	1996	906.5	911.2
15.	1974	639.0	517.0	38	1997	537.4	430.8
16.	1975	657.8	921.0	39	1998	916.2	709.3
17.	1976	720.2	784.0	40	1999	797.2	679.5
18.	1977	752.9	363.4	41	2000	397.2	335
19.	1978	599.6	531.0	42	2001	596.2	557
20.	1979	236.4	178.0	43.	2002	397.8	345.6
21.	1980	625.7	482.0	44.	2003	803	889.1

22.	1981	409.7	248.0	45.	2004	420.8	524.0
23.	1982	824.9	932				

Source: District Irrigation Department, Bharatpur (Rajasthan)

2.5 PHYSICAL AND CHEMICAL CHARACTERISTICS OF LAKE WATER

Water depth in the park varies from 0 to 200 cm. Water depth in wetland area of the park depends on water availability and the rate of evaporation in different months. The lowest water level is mostly expected and also recorded in the month of June except in 1996 and 2003 in last ten years. The highest water level is mostly recorded in the months of August and September when there is enough monsoonal rainfall in the park. But it has shown exception when it was higher in November-December in 2004 (fig.2.3a).

Water temperature in the wetland fluctuates according to the atmospheric temperature. It is lower than the atmospheric temperature in most of the months. However there were few months when it was higher than atmospheric temperature as shown by the readings taken from year 2001 to 2004. The temperature of water and atmosphere differs substantially during summers. The temperature of air and water does not differ much during winters (fig.2.3b).

The acidity and alkalinity of the lake is measured in units called pH. pH values ranging from 0–7 show acidic character and 7–14 are alkaline. When pH value of the lake falls below 4, the species diversity gets restricted. The pH value of the water in the wetland has shown considerable variations during year 2001 to 2004. From February 2001 to January 2002 the water was acidic, as the pH was below 7. Then there was a sudden shift to basic side as the pH rose to 7 and remained high till September 2003. Since then the value fluctuated around 7 till October 2004 (fig.2.3c). The lowest pH was during August, September and November 2001 and the maximum was during March 2002 when it went above 8. The trend correlates well with the supply of water to the wetland from various sources. It is noticed that pH drops slightly in all the years with the incoming of fresh water from Ajan bund.

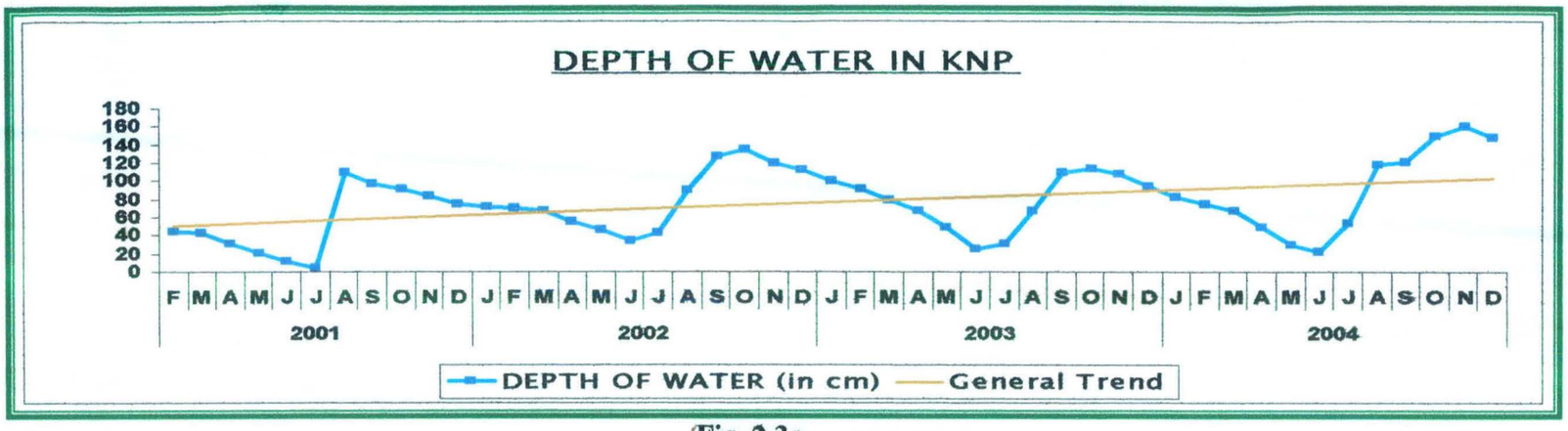

Fig. 2.3a

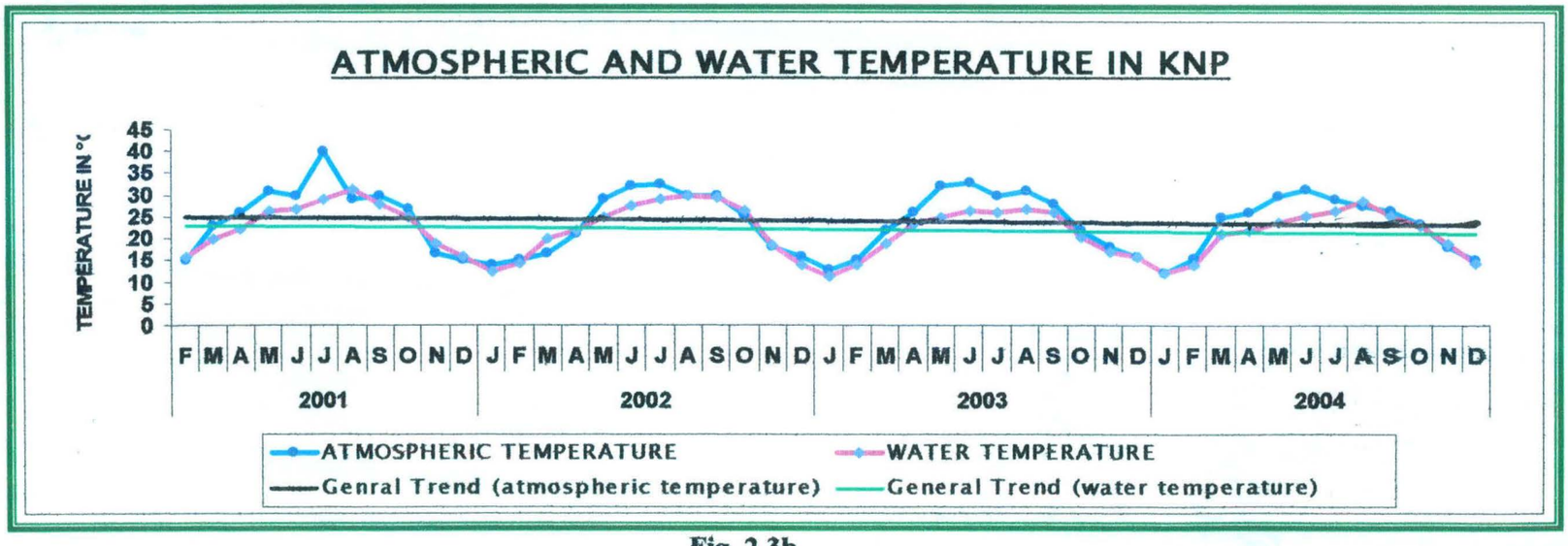

Fig. 2.3b

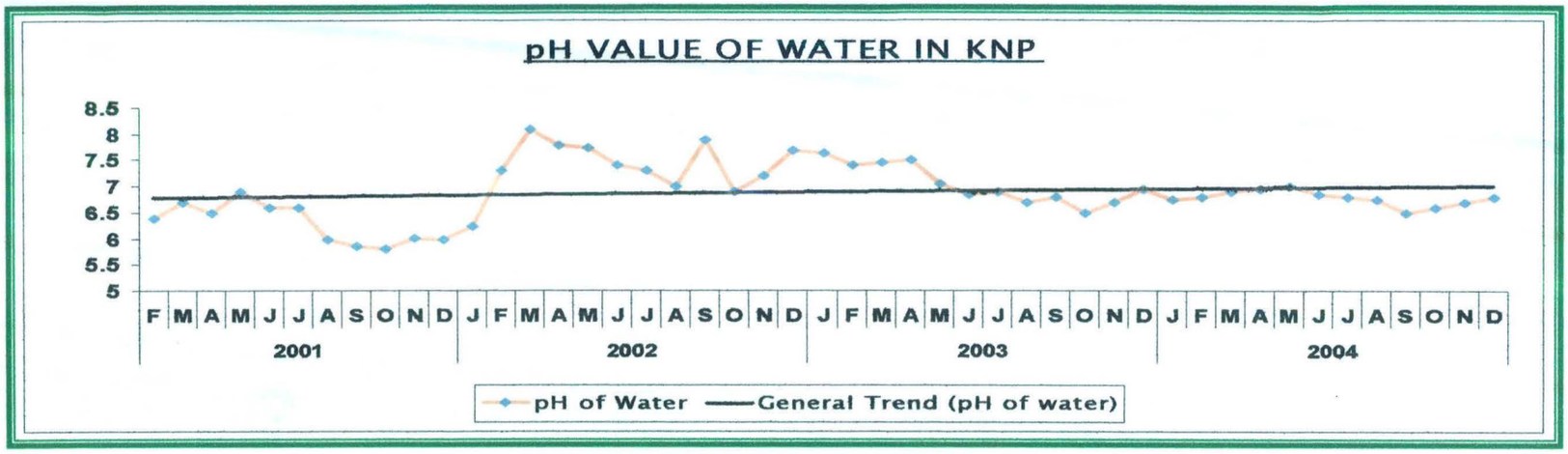

Fig. 2.3c

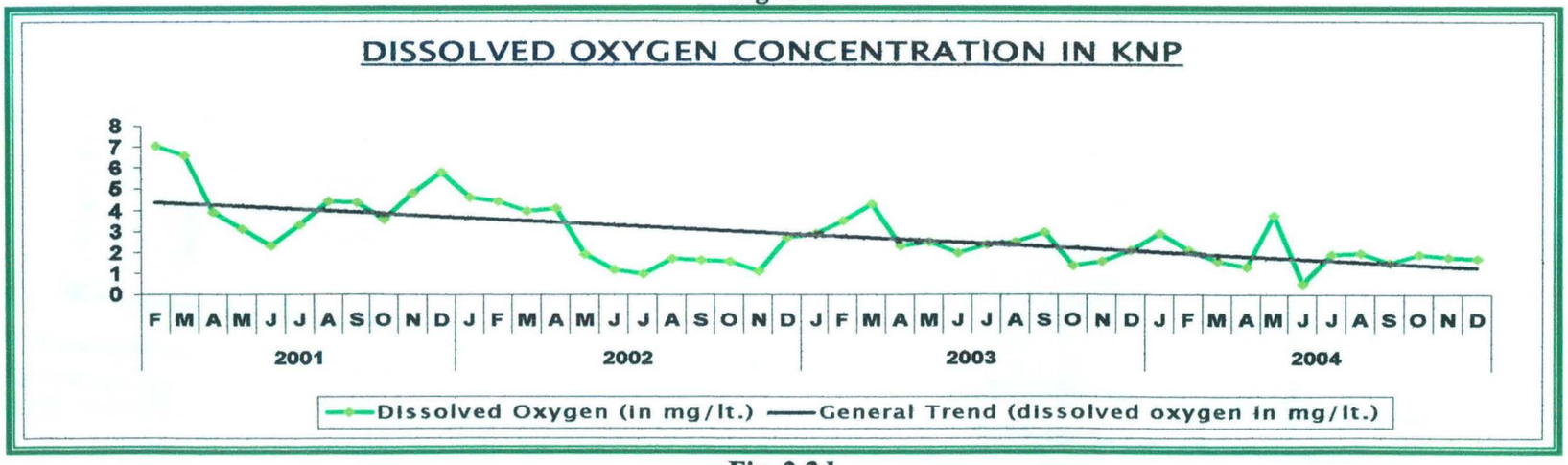

Fig. 2.3d

Source: Water Quality Monitoring Station, KNP

Dissolved Oxygen participates in many chemical and biological reactions. It is continually consumed for respiration by living beings and is produced by plant photosynthesis only when sufficient light and nutrients are available. The peak period of the value of dissolved oxygen varied from year to year. The low temperature and greater volumes of water enable greater dissolution of oxygen during winter. While the conditions during early summers or spring are ideal for photosynthesis activity resulting in an increased production of oxygen. The trend of oxygen values from 2001 shows a steady fall in oxygen level during subsequent years (fig.2.3d). It happened due to very less supply of water to the Park in these years. A stagnant water body where flow of water has decreased sometime does not come in contact of air. So, the mixing of oxygen does not happen in a proper way. Fish and other organism living in the water start to die. The growth of water plants also decreases.

2.6 FLORA

The depth of water, water quality, salinity and nature of substratum are responsible to a large extent for the distribution and abundance of plant communities in the lake water of Keoladeo wetland. The richness and diversity of plant life inside this small park is remarkable. Flowering plants were surveyed during a ten-year ecological study of the park. A total of 379 species were recorded in 1980s among which *Neptunia Oleracea* was a new addition to the Rajasthan flora[12].

A very rare specie, *Centrostachys Aquatica*, found in the park was recorded for the second time in the last 75 years from the Gangetic plains. *Acacia Nilotica, Acacia Leucophloea, Prosopis Juliflora, Prosopis Cineraria, Mitragyana Parvifolia* and *Zyzyphus* are the common trees found in the park. *Salvadora* and *Capparis* occur both as trees and shrubs.

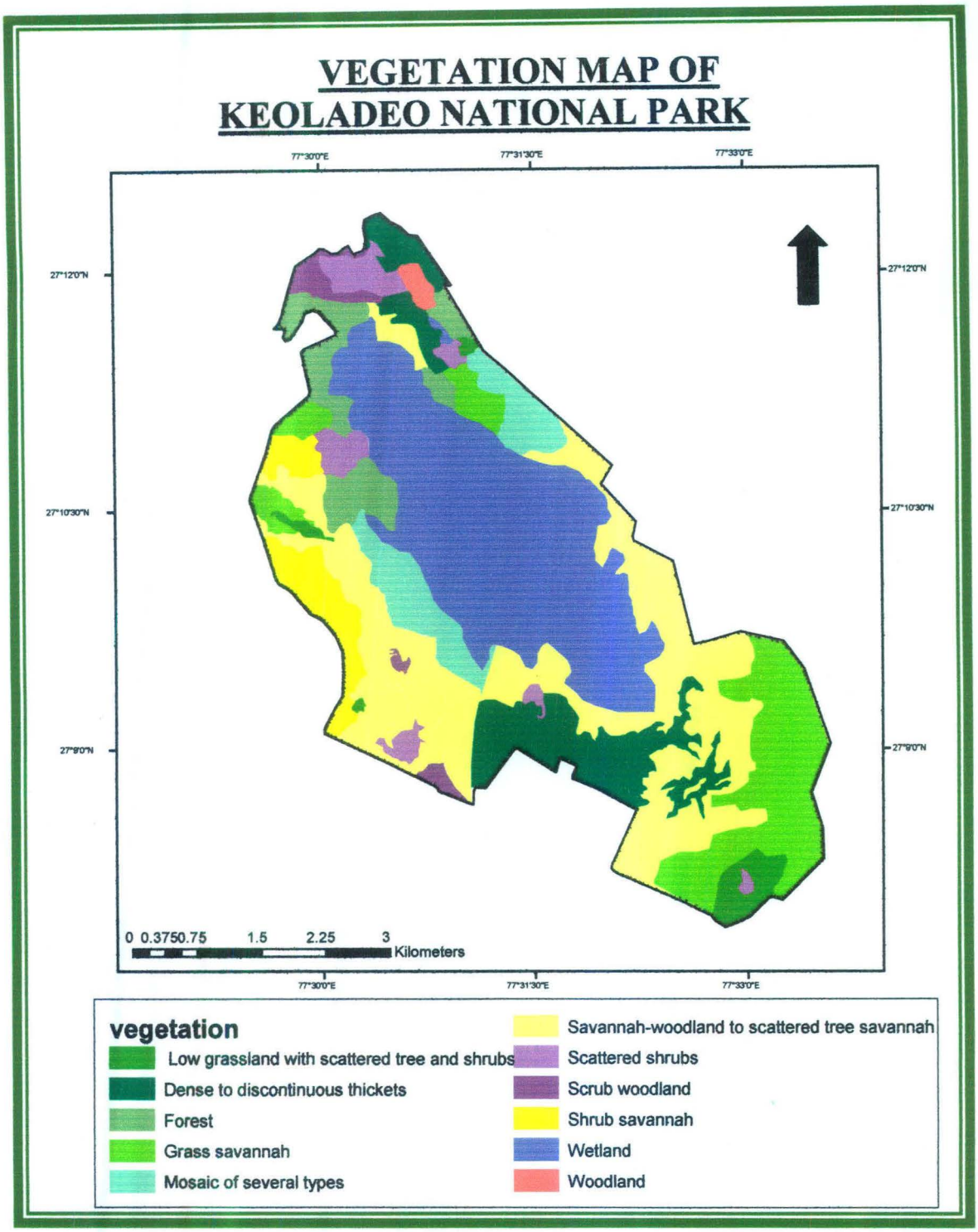

Fig. 2.4

Source: Modified (H.S. Bardoli, World Wide Fund for Nature, KNP)

Herbs are numerous, constituting more than 55 per cent of the floristic species present. The most widespread grasses in the terrestrial areas are *Vetiveria Zizanioides* (Khus grass), *Desmostachya Bipinnata* and *Cynodon Dactylon.* Of about 100 species of wetland plants, *Paspalum Distichum*, a perennial grass predominates. But *Pseudoraphis Spinescens* replaced it in many areas of the wetland in the year 1987. *Ipomoea Aquatica* is another weed found in the most of the areas[13]. Water hyacinth (*Eichhornia Crassipes*) grows up periodically and spreads widely, though it is manually removed continuously.

Sedges such as *Scirpus Tuberosus* and *Cyperus Rotundus* occupy border areas of the wetland which remain flooded for four to six months. The tubers of these species and the rhizomes of the water lilies (*Nymphaea*) are the preferred food of the endangered Siberian Cranes. Submerged plants such as *Hydrilla, Najas, Vallisneria, Ceratophyllum* and *Potamogeton* are among the major plants consumed by waterfowl[14]. The data of flora of Keoladeo wetland and its analysis has been presented in third chapter.

Keoladeo National Park has a unique mosaic of habitat types ranging from temporary swamps and potholes which hold water for a few weeks only, to flood plains where water flows over for several months.

2.6.1 Wetlands

Kadamb groves *(Mitragyna parviflora)* known as Kadam Kunj in Keoladeo, form the most impressive vegetation of the park. This breathtaking spectacle of woodland marsh is on the main road, hardly 300 m from the entrance. These centuries old trees along with the dead ones form a significant habitat for the all nesting birds like cotton teal, comb ducks and parakeets, and an excellent roost for storks and cormorants.

Apart from that, bushes and Ber trees *(Zizyphus mauritiana)* are also found in swamps of the Park. These are entwined by Heens *(Capparis sepiaria)*, a thorny plant which trails on ground, climbs the trees, thrives well in water-logged areas. It forms a valuable nesting site and is highly favoured by water hen, bulbul, doves and shrikes.

There is a wide area of emergent wetland. It is an excellent lush green habitat type which extends over half of the ecosystem of Keoladeo mainly in the form of *Typha* reeds and *Paspalum distichum.* The submerged parts provide habitat for spiders, dragonflies, mantids and food for grasshoppers. Seeds of plants form the food for migratory birds and

when shed in the water, food for fish. Flowers of the water lily *(Nymphea)* impart a picturesque addition to the impressive ecosystem of the Keoladeo. The rhizomes of water lily along with the tubers of *Cyperus*, a grass species, provide food for Siberian Cranes. Water hyacinth (*Eichhornia*) comes up periodically, spreads widely and has to be removed manually. Submerged plants such as Hydrilla, Najas, Vallisneria, Ceratophyllum and Potamogeton species are among the major plants consumed by the waterfowl.

2.6.2 Dryland

Dryland is an important and huge habitat of Keoladeo. This habitat is mainly represented by dry prairies. Forest fires are very common in the dry grasslands of Keoladeo wetland in peak summers. It has very few trees and is mainly dominated by Khus grass *(Vetiveria zizanoides)*, a tall coarse grass whose roots contain oil famous for its aroma (Plate 3). This grassland forms an excellent habitat for insects, insectivorous birds like rollers, drongos and flycatchers and also for partridges and quails. It also provides habitat to mammals such as spotted deer, blue bull, and wild boars.

The dry headlands of the Park have salt encrustations on the surface and are hence unfavourable for seed germination. In a year of good rains when salt is washed off, seeds of Jal *(Salvadora oleoides)* and Kair *(Capparis edcidua)* bearing nectar rich crimson flowers germinate. The plant that grows in salt is *Suaeda fruticosa.*

As far as the area of vegetation types is concerned, Savannah woodland with scattered trees occupies the largest area with 23 per cent. It is spread in a broad belt around the aquatic area of the Park except north and north-west of the lake. It is followed by Grass-savannah type of vegetation covering 22 percent of dryland. It covers the south-east border of the Park with some patches in north and west. Forest is spread mainly in the north-west side of the wetland area and covers approximately 10 percent of the total area. There are two patches of mosaic of several vegetation types on the north-east and west side of the wetland. It occupies near about 5 per cent area. Woodland lies in a small patch near the north border and main entrance of the Park. Mainly colonized by Ber and Babul species *(Acacia)*, woodland areas have thick foliage and provide protein – rich food for animals and birds. Juliflora is evident specie with Ber trees in woodland. It is

capable to soak water from very low underground water table. Sheesham is also found in patches on the outer areas of woodland.

2.7 FAUNA

Keoladeo wetland is a good example of ample fauna of various orders like invertebrates, fish, birds, mammals, amphibians and reptiles;

2.7.1 Invertebrates

Macro invertebrates such as worms, insects and mollusks are present mostly in terrestrial habitats. They are consumed by a variety of fish and birds, as well as by some animal species. So they constitute a major link in the food chain and in the functioning of the ecosystem. The functioning and their relationship with birds have been studied in detail.

The most interesting aspect of macro invertebrates is that they are abundant and easily replenishable. Aquatic insects include mainly bugs, beetles, strides, swimmers, chironomide larvae, and nymphs of dragon flies and damsel flies. As the water table stabilizes after two to three months of flooding, the macro invertebrates increase in numbers. Land insects are more plentiful in areas having vegetation, particularly when the plants exhibit fresh growth and bloom after the rains. Soil, moisture and humidity are the major factors influencing their presence.

2.7.2 Fish

Fifty species of the fish have been recorded from this small wetland, of which seven have probably disappeared. Forty three species were enumerated during the 1980s. The entry of millions of tiny fry into the park during July – August, with the release of water from Ajan bund makes a fascinating sight. The spectacles of the massive breeding colonies of the fish eating birds inside the park owe much to this variety of fish.

Three species, *Chela Cachius, Crosscheilus Latius* and *Pseudeutropius Atherioniodes* are new additions to the fish fauna of Rajasthan[15]. Most of the fish reach the park along with the supplied water. The predominant species are *Cirrhinus, Oxygaster* and *Chanda.* Only six species breed inside the park. These include *Channa Punctatus, C. Striatus, C. Marulius, Heyeropneuster Fossilis, Clarias Batrachus* and *Colisa Fasciata.*

The abundance of fish fry has no direct relationship with the quantum of water supplied to the Park, instead it appears to be dependent upon the monsoon in the upper catchments of the rivers and other breeding areas. Population of the larger carps showed a declining trend as the extent of open water habitats, which they prefer, got reduced considerably due to the invasion of grass in the wetland area during the mid 1980s.
The situation improved after a period of drought and clearing up of the grassy areas. The total amount of fish available in the park was estimated at a maximum of about 450 metric tons in November 1988, and a minimum of about two metric tons in July in the same year.

2.7.3 Amphibians and Reptiles

The herpetofauna of Keoladeo National Park is also very rich considering the small size of the reserve, and in comparison with that of other areas. This is especially in regard to snakes and turtles. Entire state of Rajasthan has only ten species of turtles while this small wetland alone has seven. Beside this, there are five lizard and thirteen snake species[16]. The bull frog (*Rana Tigrina*) and skipper frog (*R. Cyanophlyctis*) are commonly found in the wetland.

Over a hundred pythons have been enumerated in the park. During a sunny winter day it is never difficult to find this huge creature basking in the sun outside its burrows. There are about 46 such locations distributed mainly within the terrestrial area, particularly in the saline areas[17]. Pythons feed on birds, small mammals and even the fawns of *Chitals.*

Three species of poisonous snakes: Krait, Cobra and Russel's Wiper although present, are not commonly sighted within park. The Checkered Keelback water snake (*Xenochropis Piscator*) was very common before the drought of 1986-87, but became scare thereafter. This specie, at times, is eaten by herons, storks and the sarus crane. The common Indian monitor lizard *(Varanus Bengalensis)* preys upon eggs of birds and pythons.

All the seven species of the turtles are aquatic. The dominant specie, the Indian flap-shell (*Lissemys Punctata*) also moves to drier areas. The brahminy river terrapin (*Hardella Thurji*) is also common. Two turtle species, the spotted black terrapin

(*Geochlemys Hamiltoni*) and peacock soft-shell (*Trionyx Hurum*) are new entries in the fauna found in Rajasthan.

2.7.4 Mammals

The park is equally rich in mammals with 27 identified species. Of the six species of larger herbivorous found here, three are more abundant. There are nilgai numbering about 200, feral cattle about 1100 and cheetal about 250 while black buck and sambar are fewer, numbering about 20 to 25[18]. Only one or two individuals of the hog deer have been sighted along with cheetal. Wild boar is common and is reported to sneak out of the park to raid crop fields in the villages surrounding the park. The same is true about the porcupines, though these are fewer in number. These ungulates wade through water for eating soft grass *Paspalum Distichum* in winter, but move towards woodland or savanna woodland in summers.

Two species of mongoose, the small Indian mongoose and the common mongoose are found occasionally. Two lesser cats namely the jungle cat and the fishing cat though rare have been sighted inside the park.

There is no major mammalian predator inside the park. A tigress dwelled in the park for four years which escaped from the jungles of Karoli. It was found dead in the park in year 2004 in decomposed condition. Before that a leopard was seen in the park between September 1987 and May 1988. Jackals, whose howls in chorus echo in the park, have taken the role of predators. There are about 80 jackals in the park[19].

Hyaenas are now extinct specie in the park; only five individuals were last sighted in 1989. There are, however, many species of rats, mice, gerbils and bats. The bi-coloured leaf-nosed bat *(Hipposideorus fulvus)* which inhabits python burrows is a new entry in fauna records of Rajasthan[20]. Giants bats and the flying fox *(Pteropus gigantius)*, though not colonial, are observed here.

Population of nilgai and feral cattle is increasing. The population of cattle, which are left inside by the villagers in the neighbourhood has been increasing, resulting in overgrazing. The population of sambar has not been increasing since the 1960s[21]. Although one or two fawns are produced every year, an almost equal mortality rate has kept their numbers steady. The black buck population decreased in second half of the

1980s, probably due to a reduction in its preferred habitat of open grassland with short grasses as a result of the extensive growth of Khas grass. Exploitation of Khas grass was stopped at the beginning of 1980 after the orders of the State Government on the recommendations by the park administration.

2.7.5 Birds

Keoladeo National Park, an oasis surrounded by croplands and villages, has an enormously rich and diverse bird fauna and is popular as a 'bird paradise'[22] (Plate 4). Records of large number of ducks visiting this wetland during the Princely State times when it was a duck shooting reserve for the Maharaja of Bharatpur and his guests, are inscribed on the pillars near Keoladeo temple. In addition, the wetland is a wintering area for massive congregations of waterfowls. Also it has been the only regular winter refuge in India for endangered Siberian cranes.

A decade long study (1980-90) by the Bombay Natural History Society at this wetland was initiated by Dr. Salim Ali, the renowned ornithologist. The study focused on the avifauna and their habitat. Over 370 bird species have been recorded in the park. Two-thirds of the species are land birds while a few are semi aquatic. The large congregations of migratory waterfowl cover the water surface during mid-winter. There are about twenty five known duck species in the park. Cotton teal, sport bill, lesser whistling teal and comb duck are the main resident duck species while the others are migratory such as pintail, common teal, shoveller, gadwall, graylag and barheaded geese, wigeon, common pochard and coot. Marbled and Baikal teals are under the category of threatened species.

Waterfowls arrive in the park in September, reach a maximum number during December-January and thereafter start the return migration. By April-May most of the migrants depart. If water is available for a longer period, some resident ducks may remain and breed in summer[23]. The highest number of waterfowl counted was about 26,000 in January 1986 corresponding with enormous water input in 1985. The species utilizing the area depend upon the habitat available, the type of vegetation and depth of water[24].

Rosy pelicans have been the dominant crane specie to migrate to the Park while endangered Dalmatian pelicans, Spotbills and a few Flemingos also visit the park. These

are the elegant species contributing greatly to the avian diversity and the beauty of the park. Breeding colonies of fish-eating birds comprising thirteen species, many of which nest in hundreds or thousands are another spectacle at KNP. The painted stork, openbill stork, cormorants and egrets are dominant species, although herons, spoonbills and ibis are also not uncommon. During the post-monsoon and early winter period the park resounds with the cacophony of the voracious chicks of these species[25].

The number and variety of birds of prey increase during the nesting of herons and storks. The raptor fauna of the park is incredibly high in a well flooded year. Forty two species of raptors have been recorded excluding owls and nightjars. Migratory eagles and harriers dominate the scene at the wetland during peak winter.

The Siberian crane and Sarus crane are the most attractive migratory birds of the park. Sarus cranes are found in congregations of about 150 to 250. These are believed to pair for life and even commit suicide when separated. About ten to twelve pairs breed inside the park in a well flooded year. This specie has been affected by environmental contamination during last decade. Sarus crane, although still common in Gujarat, Uttar Pradesh and Rajasthan, is on decline mainly due to habitat loss and pesticide pollution.

The white Siberian crane aptly called 'snow wreath' or 'lily of birds'[26], is a highly endangered migrant from western Siberia. It has brought international attention and fame to this park. The Siberian crane mainly feed on tubers of sedges, rhizomes of water lilies and insects from the marshes inside the park. It is very loyal to its partner. Their habitat has been adversely affected by the overgrowth of *Paspalum Distichum* weed. Droughts have also adversely affected this specie. Less water, increase in the atmospheric temperature and weed growth have decreased their winter population in the park during last fifty years from two hundred to nil.

To conclude, Keoladeo wetland is probably a remnant of an oxbow lake of river Yamuna. It was developed by the rulers of the area for their entertainment as duck shooting reserve. It later became a national Park. Owing to its shape, it has a centripetal drainage. Being located in a semi-arid region, this wetland requires additional water which is supplied to it through a set of canals. The water in the wetland possesses certain specific characteristics. The depth of water varies in relation to water availability, rate of

evapo-transpiration and siltation. The pH value indicates the nature of water to be basic, but it varies as per the input. Total alkalinity is high during summers and decreases as winters proceed. A wide variety of flora and fauna is found in the area. Important species of flora include *Acacia Nilotica*, *Prosopis Juliflora*, *Mitragyana Parvifolia*, *Zyzyphus*, *Vetiveria Zizanioides* and *Paspalum Distichum* etc. Important faunal species found there are Siberian and Sarus cranes, Painted storks, Grayleg geese, Herons, Great Indian Egret, Nilgai, Cheetal, Jackals, Pythons, Jungle cat etc. Thus it would not be embellished to say that this wetland is no less than a 'Paradise' in itself.

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Chapter 3

PROBLEMS AND POTENTIALS OF KEOLADEO NATIONAL PARK

Every wetland has certain values and potentials attached to it. These potentials, directly or indirectly, benefit human beings. This is why these wetlands are economically exploited. When this exploitation exceeds the limits, it becomes overexploitation. It is due to overexploitation that the wetland ecosystem starts facing serious problems. Understanding the values and problems of Keoladeo wetland is an important step towards its management and conservation.

Keoladeo wetland is a valuable resource for the society in many ways. It has economic, ecological, cultural values etc. Population of the surrounding villages has been making use of the Park for these values since its establishment in 17^{th} century. This has caused a lot of stress which is increasing as the population is growing.

Keoladeo wetland is also facing many problems some of which have been created by people living around it while others are nature induced. So, there is a need to identify the problems which are responsible for the deteriorating conditions of this valuable wetland. It is only then that conservation strategy for sustainable development of the wetland can be evolved. The following problems are accountable for worsening situation of the Park;

a) Varied and unpredictable climatic conditions especially in terms of rainfall and temperature.
b) Siltation as it affects the water depth of the lake.
c) Improper water storage affecting the biota.
d) Environmental contamination adversely affecting the bird fauna.

After discussing the problems, their consequences, it is important highlight the values of the area. These values have been categorized as:

a) Ecological values
b) Economic values
c) Cultural and aesthetic values

3.1 PROBLEMS

3.1.1 VARIED CLIMATIC CONDITIONS

It is a well established fact that water is a source of life for wetlands. It is true for Keoladeo Wetland as well. The ecosystem of this small wetland is involved in a wonderful cycle of productive exchanges. Monsoonal rain plays an important role in filling life in the dying lakes of this wetland in summers from June to September. It has been noticed that in the year when monsoonal rain was recorded less than the expected, the ecosystem faced a deadly environment with less immigration and nesting of birds. A large part of the wetland also turned into marshy to dryland. It is important to mention that this wetland can sustain in semi-arid climate. It is very cruel for this life zone that the monsoonal rain often shows an insufficient character.

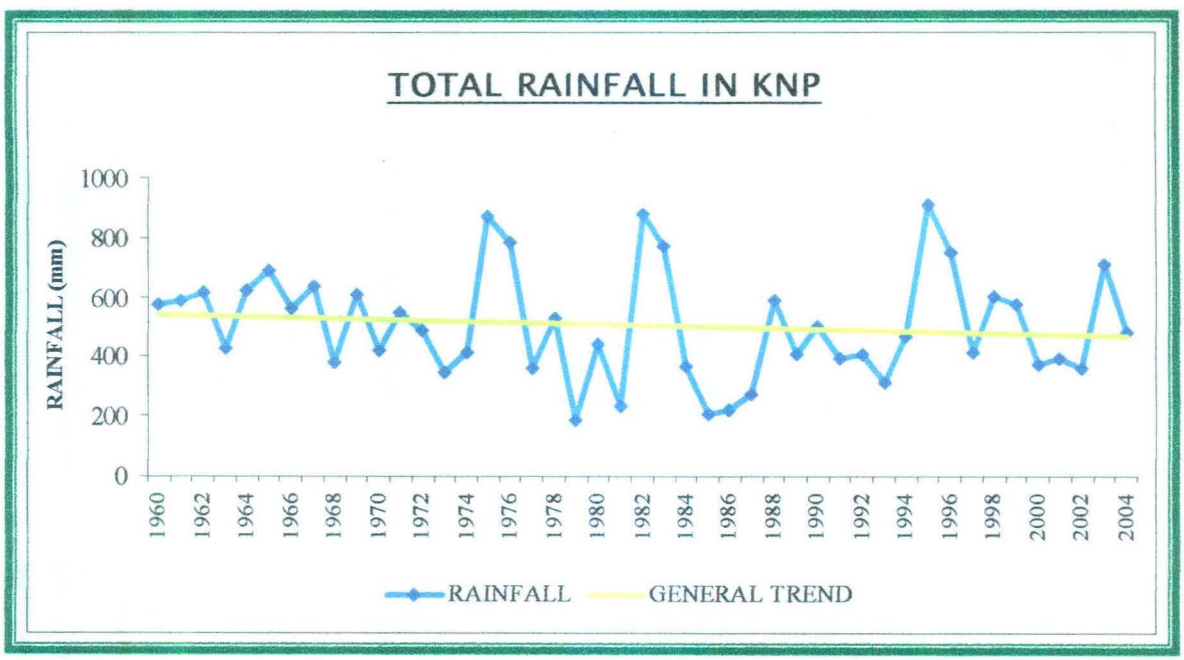

Fig.3.1

Source: State Meteorological Department, Jaipur, Rajasthan

Figure 3.1 shows great uncertainty of rainfall in the Park during 1960 to 2004. The amount of rainfall in the Park shows a declining trend during last 40 years. Average annual rainfall has been 506.58 mm during this period. The Park received only 189 mm rainfall in 1979 while the highest of 911 mm was recorded in 1995. It got the least

rainfall in 1980s with an annual average of 441.5 mm. It probably happened because of the drought of 1981 and successive droughts from 1984 to 1987. Rainfall had been highest in the decade of 1960 with an annual average of 572.5 mm. On an average the amount of rainfall received per year has fluctuated around 600 mm with a few exceptions (table 3.1).

Table 3.1

Total Rainfall in Keoladeo National Park (1960-2004)

Year	Rainfall in mm	Year	Rainfall in mm	Year	Rainfall in mm
1960	578	1975	874	1990	503
1961	591	1976	783	1991	399
1962	615	1977	361	1992	412
1963	432	1978	531	1993	318
1964	624	1979	189	1994	471
1965	689	1980	443	1995	911
1966	564	1981	237	1996	751
1967	639	1982	881	1997	419
1968	385	1983	769	1998	604
1969	608	1984	372	1999	577
1970	423	1985	211	2000	376
1971	548	1986	224	2001	397
1972	487	1987	278	2002	364
1973	348	1988	591	2003	712
1974	417	1989	409	2004	481

Along with varied rainfall, temperature fluctuations have also played a significant role in adding to the problem of the wetland. It is quite evident from figure 3.2 that during past few decades the atmospheric temperature has increased. It has created manifold problems for the wetland like increased evapo-transpiration causing shrinkage of wetland, decline in the immigration of birds which are very sensitive to atmospheric temperature etc.

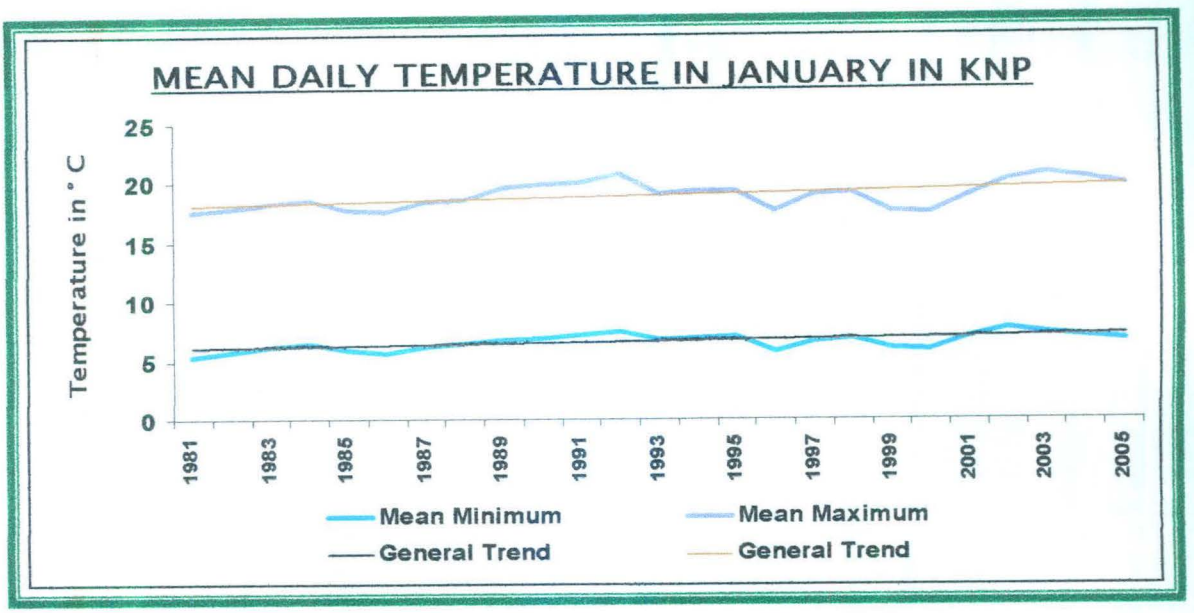

Fig.3.2

Source: State Meteorological Department, Jaipur, Rajasthan

The mean minimum daily atmospheric temperature of January in Keoladeo ranged between 5.4 °C and 7.7 °C during 1981 to 2005. Fluctuations in mean minimum daily temperature showed an increasing trend during this period. It was recorded lowest in 1984 and highest in 2002. While the mean maximum atmospheric temperature of January in Keoladeo ranged between 17.5 °C and 20.8 °C. It was recorded lowest in 2000 and highest in 1992. Like mean daily minimum temperature, mean daily maximum temperature of January has also shown an increasing trend in Keoladeo (table 3.2).

Table 3.2

Year	Mean Minimum	Mean Maximum	Year	Mean Minimum	Mean Maximum
1981	5.4	17.6	1994	6.9	19.3
1982	5.8	17.9	1995	7.1	19.4
1983	6.2	18.3	1996	5.8	17.6
1984	6.5	18.6	1997	6.6	19
1985	5.9	17.8	1998	6.9	19.2
1986	5.7	17.6	1999	6.1	17.6
1987	6.2	18.5	2000	6	17.5
1988	6.5	18.7	2001	7.1	18.9
1989	6.8	19.6	2002	7.7	20.2
1990	6.9	19.9	2003	7.4	20.7
1991	7.2	20.1	2004	7	20.4
1992	7.5	20.8	2005	6.8	19.8
1993	6.8	19			

It is evident from figures (3.1 and 3.2), the rainfall has decreased and atmospheric temperature of January has increased over time. Due to increase in atmospheric temperature, the rate of evapo-transpiration has considerably increased. Decrease in rainfall over the years has accentuated the problem. This has resulted in decrease in the volume of water resulting in the shrinkage of the wetland.

3.1.2 SILTATION

Siltation is perhaps the most common problem faced by every wetland. Bharatpur has a 'bowl' shape. There were successive floods in Bharatpur town till 1980 which had both positive and negative aspects. These continuous floods brought plenty of water in Keoladeo wetland which was must for its existence. At the same time it deposited a large volume of silt in the lake of the wetland. It was not easy to remove this silt.

The inflow of water into the wetland still brings a large amount of silt with it. This inflow increases during the rainy season. However, this inflow and outflow hardly balance each other and silt starts settling down at the bottom of the lake. This has resulted in making the lake shallow and reduction in the waterspread area.

The canal system feeding the wetland through Ajan bund reservoir during monsoon carries an enormous load amounting to 1.9 million tones of silt a year. It renders the lake shallow and turbid. The negative impacts of this massive inflow of silt are manifesting themselves in three fields:-

- The silt is getting deposited in the bottoms of the lakes rendering it shallow.
- Resulting in gradual decrease of water spread area of the lake.
- Due to heavy siltation in G and H blocks and surrounding areas, the wetland has disappeared from there.

3.1.3 IMPROPER WATER STORAGE

Water storage is a necessary process to maintain the ecosystem of a lake or a wetland. The fragile ecosystem and the life cycle of Keoladeo wetland also depends on water storage system in its lakes. As stated earlier, the main source of water to the wetland of Keoladeo is a temporary reservoir called Ajan bund, situated about a kilometer southwest of the Park. Water from Ajan bund reservoir is taken to the Park through a canal, namely Ghana canal (Dakan Mori). Ajan bund reservoir receives water

from the rivers Gambhir through Pichuna canal, and Banaganga through Uchain canal. The water input to the wetland from the reservoir during the last 30 years shows wide fluctuations, the lowest being 18 mcft in 2004-05 and the highest 583.96 mcft in 1992-93 (figure 3.3). Water input was 500 mcft or above only in 9 years out of 30 years. The actual water requirement of the wetland is 600 mcft of water per year. The water supply to the Park has shown an overall declining trend since 1992-93 (table 2.1).

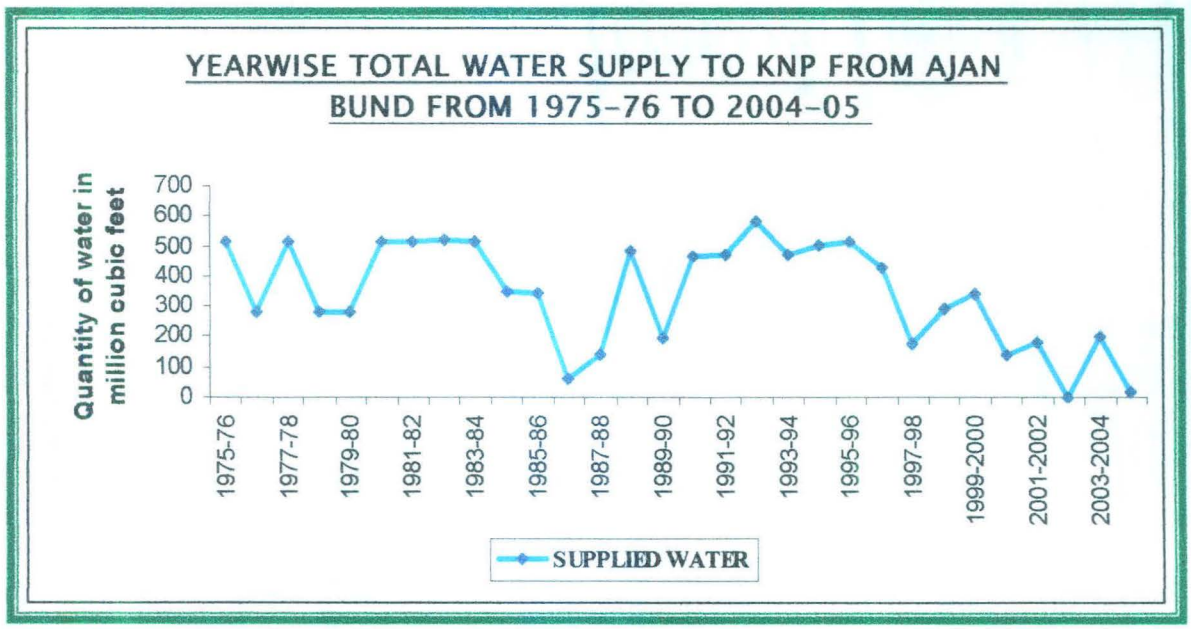

Fig.3.3

Source: District Irrigation Department, Bharatpur, Rajasthan

The water storage of a given year is determined by the water input of that year and the quantity carried over from the previous year. Water is released into the park between July and September. Hence, the maximum average water depth in a year is during September or October and it decreases considerably during summer because of high evapo–transpiration. The wetland has not received the required water since the last decade. This continuous decline in the water input into the area is posing serious threat to the existence of the Park.

Ground Water Recharge

The feasibility of ground water supply has been discussed by Park management and the Government when the wetland of Keoladeo faced dry seasons successively. But

there have been no positive results in this direction. The team of scientists from the 'State Geological and Ground Water Department' has found out few causes on this issue;

- Upper aquifers contain saline water which is not fit for the life of this fresh water wetland ecosystem.
- Lower confined aquifer is also saline with electrical conductivity.
- Suitable water quality required for survival of ecosystem of the wetland is not available under ground.
- Number of tube wells required is large i.e. approximately 150.
- Continuous fluctuations in recharging of ground water table by percolation of rain water.

The team prepared final hydro geological recommendations in January 2005. It stated that – 'Development of ground water structure in the vicinity of Keoladeo National Park Wetland is not feasible at any cost'.[1]

However, when water input is very low in the wetland then ground water is the only option to sustain it. It had to be recorded in past few years in 1997, 2000, 2001 and 2004. In these years ground water was pumped up and was supplied to the wetland maintaining the water level. Despite its negative characteristics, ground water played a vital role at the time of crisis.

The ground water table is a function of numerous variables like amount of rainfall, infiltration, surface runoff etc. The post monsoon depth of ground water showed wide fluctuations during 1991 to 2003 (Fig. 3.4). It was closest to the surface being 0.35 meter in 1998 while farthest from the surface being 5.45 meters in 2002. Water table has gone down from 0.35 meter to 5.45 meters in the last five years. The ground water table was close to the surface in 1998 and 1999 due to good rainfall. In certain years post monsoon depth has gone down even below the pre monsoon depth as it happened in 1993, 2000 and 2002. This was probably because comparatively less rainfall was recorded in these years.

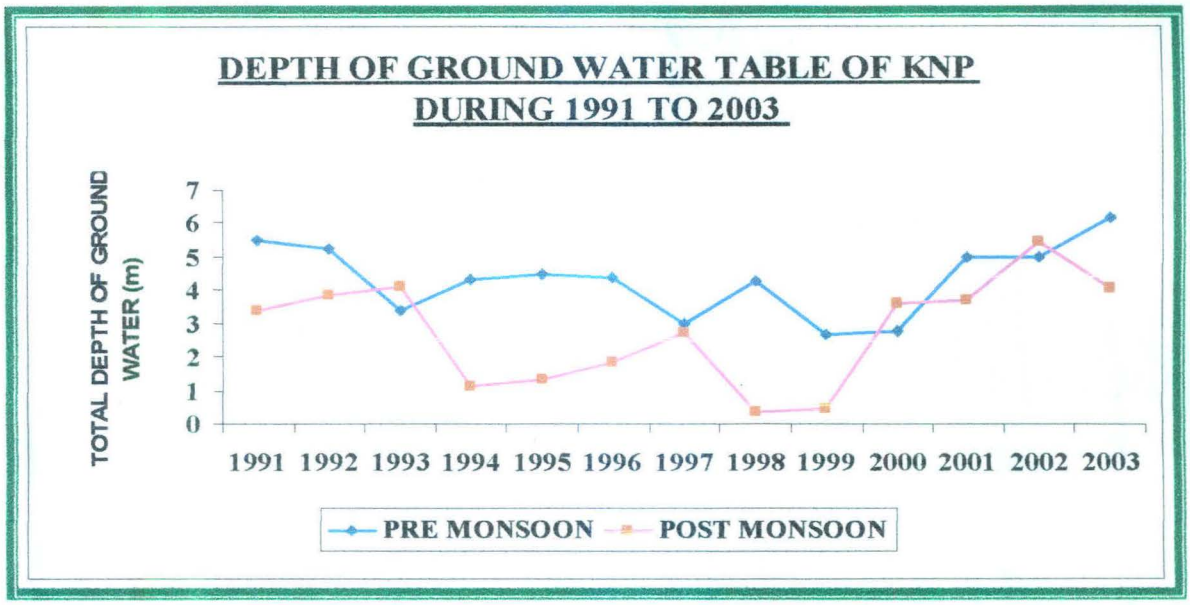

Fig.3.4

Source: Ground Water Department, Jaipur, Rajasthan

3.1.4 ENVIRONMENTAL CONTAMINATION

Keoladeo is a paradise for different species of birds. A lot of migratory birds come here and nest along with the local birds. But many of these lose their lives with a dread end because of the environmental contamination. Of late, a number of birds have been found dead inside the Park. Notable among these are the Sarus Crane, Ring Dove, Blue Rock Pigeon and Greylag Goose. Twelve Sarus Cranes (3 in 1999-2000; 5 in 2000-01 and 4 in 2001-02) and thirty-eight Ring Doves (10 in 1999-2000; 17 in 2000-01 and 11 in 2001-02) were found dead during 1999-2002. Many more might have died inside and outside the Park as well, and may have gone without notice.[2]

Strangely the mortality occurred during winter months in all the years. Samples of all dead birds' tissues were sent to the pesticide testing laboratory of Tamil Nadu Agricultural University. The results pointed towards the application of pesticides (Aldrin, Dieldrin, DDT and BHC) in the wheat fields in the villages surrounding the Park. Aldrin, an organochlorine pesticide, is being continuously used to treat wheat and mustard seed to control termite. Many species of birds go to the adjacent agricultural lands to feed. These pesticides are being used in the catchment areas of the river Gambhir from where

the Ajan bund reservoir receives water. The reservoir is turned into a crop field after the water is released into the Park and the farmers make use of fertilizers (Plate 5). Thus, a large volume of contaminated water reaches Keoladeo wetland.

Later, few samples of water were taken from Ajan bund reservoir and other water bodies existing around the Industrial area of Bharatpur town. Remnants of pesticides were found in the samples taken from the reservoir. High concentration of some heavy metals like Lead (Pb), Copper (Cu), Chromium (Cr) and Zinc (Zn) were tested and found in the effluents of the Industries.[3]

Another distressing aspect was that the Sarus cranes died because of the pesticide contamination in their brains, livers and flight muscles. After their death, their partners, those were not contaminated, remained inactive. They kept themselves aloof and did not feed in the following three–four days, and died on the fifth day. This happened with four pairs. A lot of newly born chicks from the eggs either couldn't survive for more than two to five hours or were born dead. This has put a serious question to birds' survival in such a contaminated environment.[4]

The samples of eggs of eight species of colonial breeders were selected for analysis in the laboratory. These included the Larger Cormorant, Indian Shag, Darter, Grey Heron, Cattle Egret, Large Egret, Painted Stork and Spoonbill. In the chemical test, low concentration of Endosulfan (0.004 to 0.015 ppm on wet weight basis) was detected in all the eggs. Eggs of the Darter and Large Egret contained more BHC (0.49 and 0.45 ppm respectively) than did the eggs of other species. Dieldrin residues were detected in the eggs of all species, especially in the eggs of Grey Heron and Painted Storks (5.96 and 5.78 ppm respectively).[5]

On the other hand, eleven species of birds were selected to find out the heavy metal contamination. These were Indian Shag, Large Egret, Median Egret, Night Heron, Rosy Pelican, Pond Heron, Grey Heron, Painted Stork, Pheasent tailed Jac, Indian Moorhen and Greylag Goose. The Tissues of brain, liver, kidney and flight muscles were sent to the laboratory for the test.

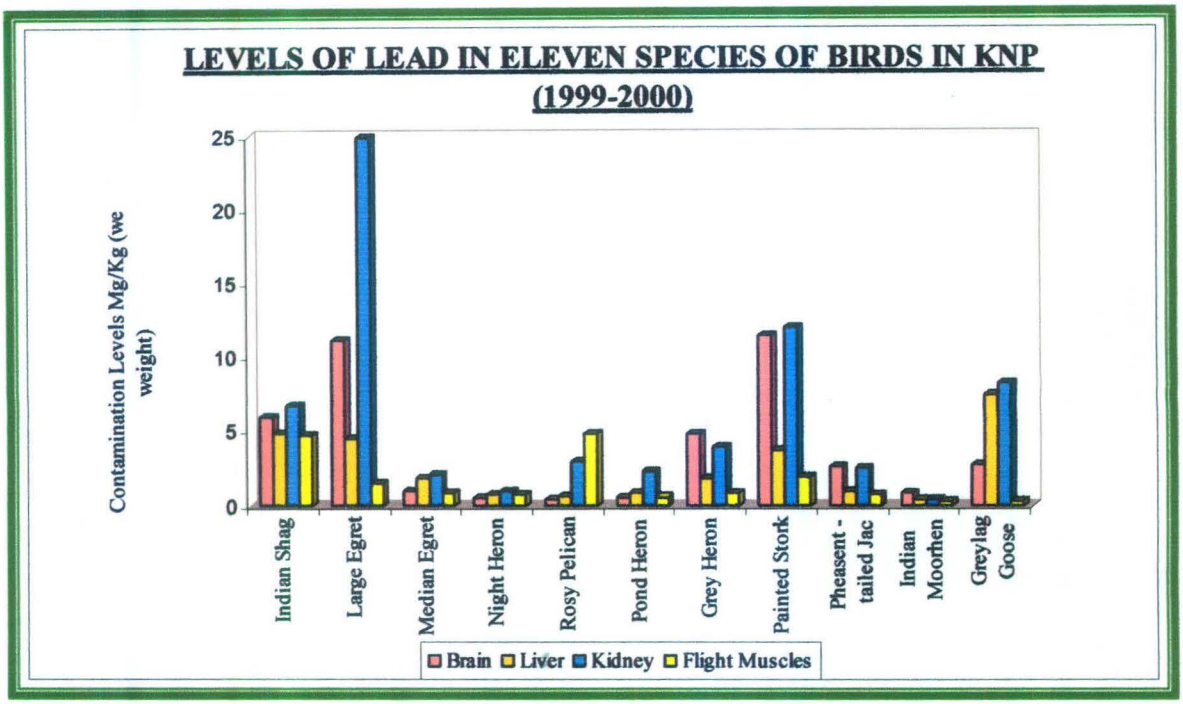

Fig. 3.5 (a)

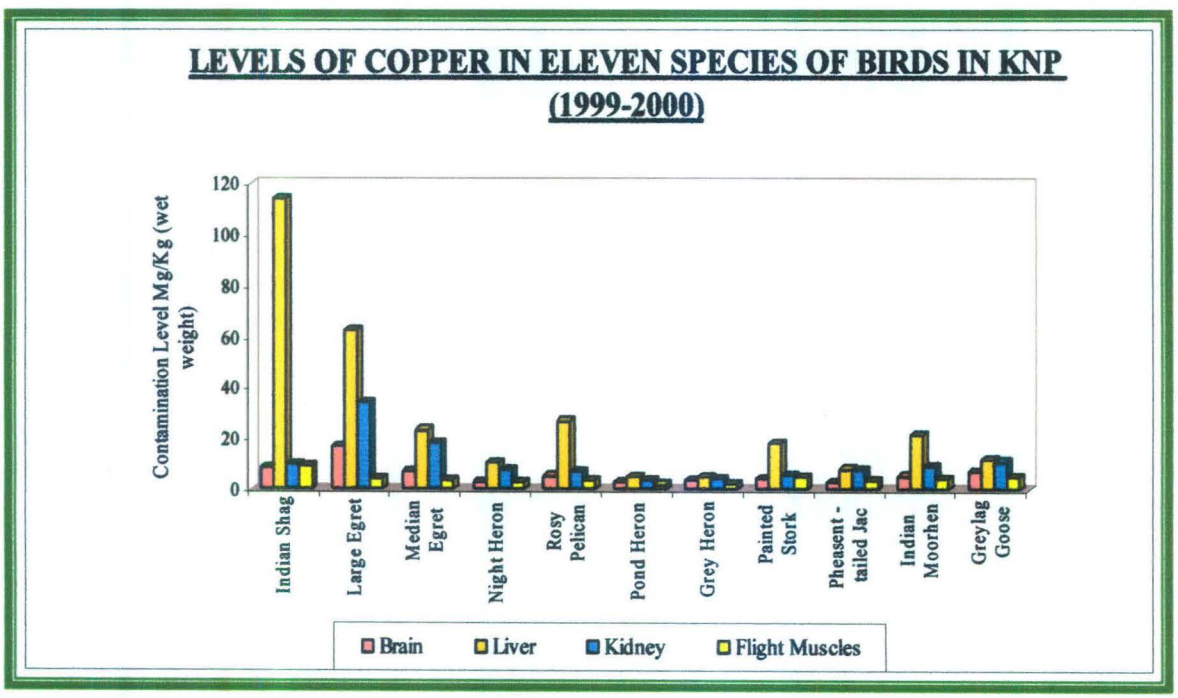

Fig. 3.5 (b)

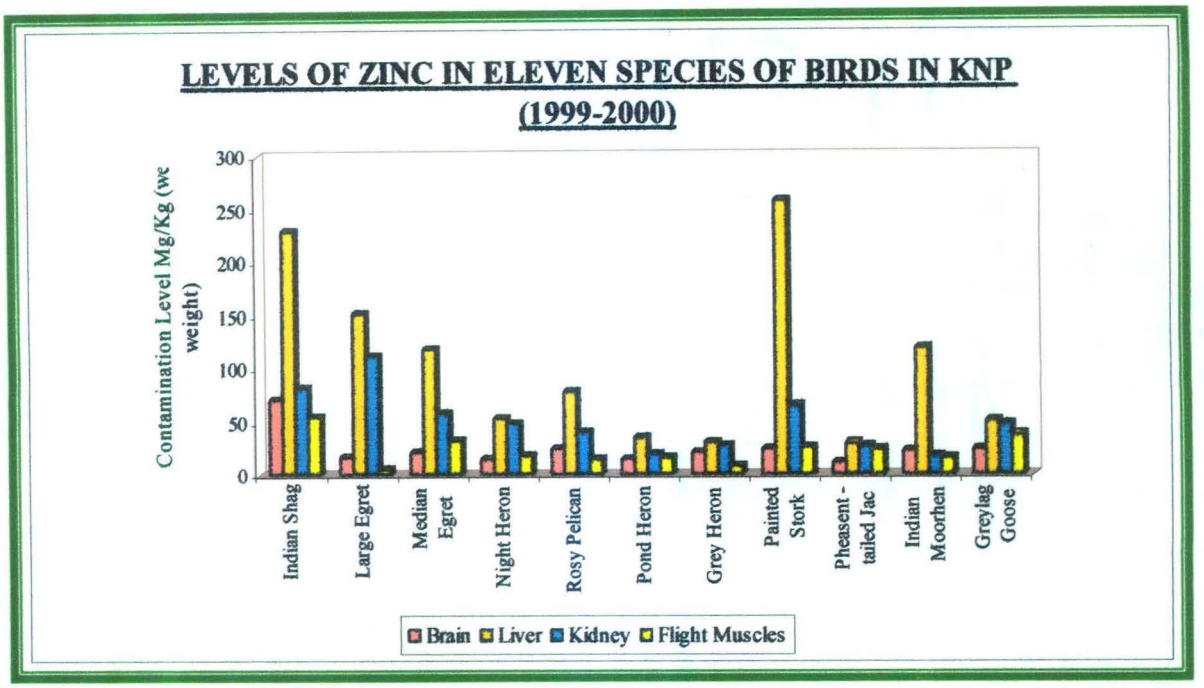

Fig.3.5 (c)

Source: Forest Department, KNP, Bharatpur

After the test, the quantities of Lead (Pb), Copper (Cu) and Zinc (Zn) were found higher than other metals. It was found that Lead affected the Kidneys more than other organs in most of the bird species [fig.3.5 (a)]. Contamination level of Lead was highest with 25 mg/ Kg in the kidneys of Large Egret. While the flight muscles of all bird species were less affected. Indian Moorhen was the least contaminated in all organs.

A high quantity of Copper was also found in the tissues of the birds [fig.3.5 (b)]. Liver was the most contaminated organ in all bird species. It was found highest 117.6 Mg/Kg in Indian Shag and lowest in Herons with a little amount of 5.1 Mg/Kg. While the tissues of brain were found least affected in all the birds except Large Egret where it was higher than flight muscles.

The quantity Zinc was found upto a dangerous level in the tissues of the birds [fig.3.5 (c)]. Again liver was the most contaminated body organ in all the bird species. It reached to the highest level of 269 Mg/Kg in the liver tissues of Painted Stork. The tissues of brains and flight muscles were least affected with a few exceptions.

After the analysis, it was found that the Herons, both Pond and Grey, were least contaminated bird species by these three metals. While Indian Shag and Large Egret were the highest contaminated birds among all the eleven bird species taken.

Certain species are found to be most contaminated owing to their specific eating habits. Large Egret, Painted Stork and Indian Shag are the bird species which go out of the park in search of food. Consequently these tend to consume contaminated food and water.

Many recommendations and preservative methods have been discussed in the reports of many researchers like Dr. Salim Ali, V.S. Vijayan, Lalitha Vijayan, Gargi Rana, Dr. Harendra Singh Bargali and others. But the Park administration and Government have not come forward to implement these recommendations.

If proper and sufficient water and food is made available in the Park, birds will not fly out of the Park to search food and water in their breeding season of winter months. Apart from this, the farmers and peasants also can be made aware about the contaminated environment. They can be asked to use natural and bio fertilizers in place of chemical fertilizers or they can be taught to lessen the use of pesticides. While the industries can be given legal warning to reduce the effluents coming out and treat these effluents according to the rules of Central Pollution Control Board (CPCB).

If the same condition persists, very soon all the migratory birds and all the breeders will start to search some other wetland or lake to migrate and breed. Thus, the paradise of birds will certainly be lost.

3.2 CONSEQUENCES

Keoladeo wetland which is a Ramsar Site is a peaceful refuge for many resident and migratory bird species. But this wetland is facing deteriorating conditions due to manifold problems prevailing in the area. These problems have started to show some very harmful consequences which might lead this to its destruction. There is an urgent need to look into the matter and to take appropriate steps before it is too late. Some of the most dreadful consequences are as follows:

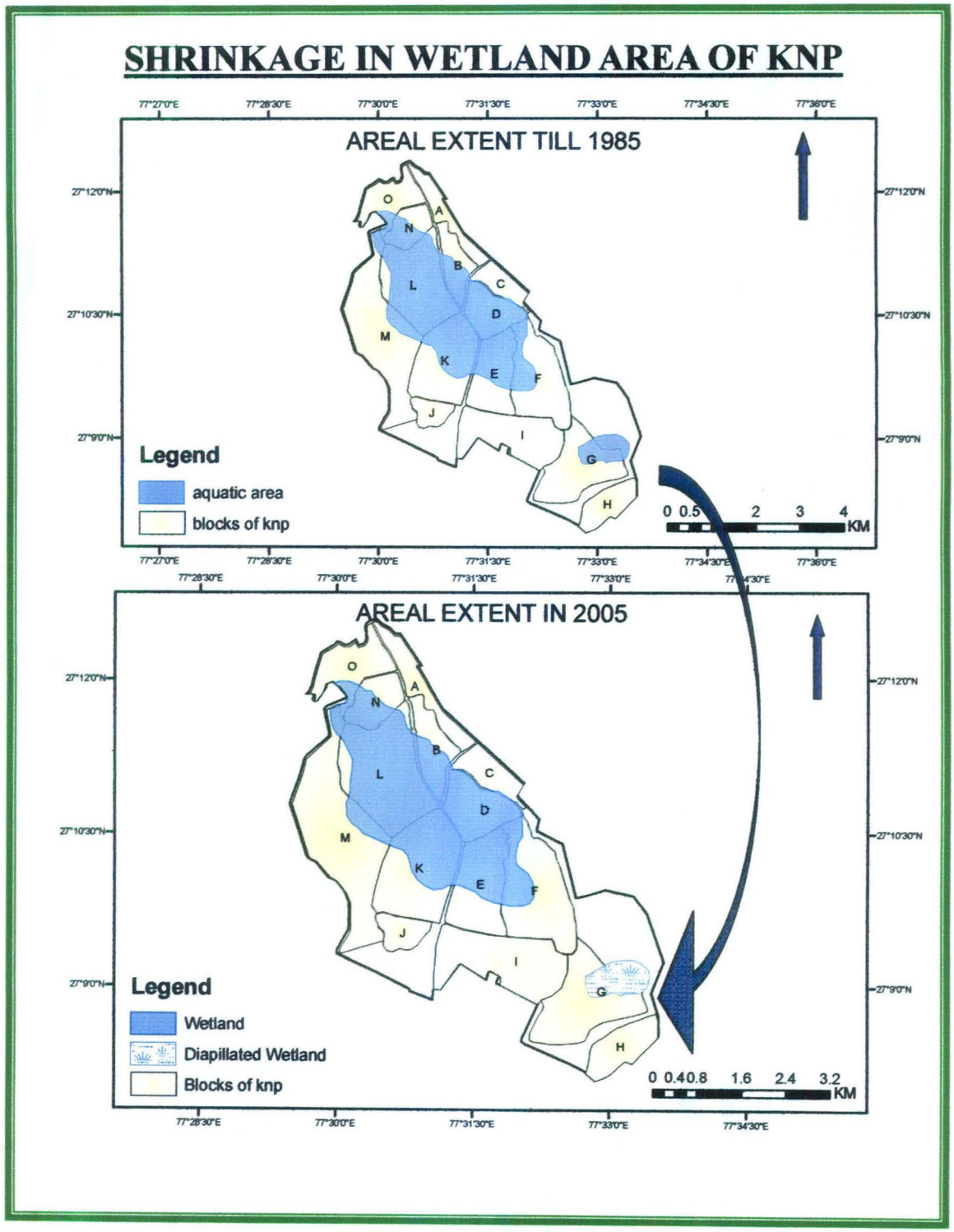
SHRINKAGE IN WETLAND AREA OF KNP
AREAL EXTENT TILL 1985
77°27'0"E
77°28'30"E
77°30'0"E
77°31'30"E
77°33'0"E
77°34'30"E
77°36'0"E
27°12'0"N
27°10'30"N
27°9'0"N
O
A
N
B
C
L
D
M
K
E
F
J
I
G
H
Legend
aquatic area
blocks of knp
0 0.5 2 3 4
KM
AREAL EXTENT IN 2005
Legend
Wetland
Diapillated Wetland
Blocks of knp
0 0.40.8 1.6 2.4 3.2
KM

Fig. 3.6

3.2.1 Shrinkage in Wetland Area

In last two decades the wetland has experienced shrinkage in area caused by many factors, variations in climatic conditions being the important one. Recurring droughts, insufficient rainfall and water supply from Ajan bund reservoir, continuous deposition of silt in the wetland areas, increase in the growth of weeds and increase in the area of grassland are the probable reasons for the shrinkage of wetland area of Keoladeo.

It is quite evident from the figure 3.6 that a major section of wetland existed in block G of the Park till 1985. That also used to be a good shelter for the nesting birds. But with the successive droughts, insufficient water supply and increased siltation, the wetland from this area started disappearing. Later on it turned into a dilapidated wetland with very small pools of water here and there. Siltation and weeding even destroyed whatever water was remaining. Presently the area has changed into savanna grassland and woodland. This readily shows that if not taken care of, it might lead to disappearance of entire water spread area of these blocks.

3.2.2 Declining Immigration of Siberian Crane

Siberian crane is aptly known as 'snow wreath'[6] or 'lily of birds'[7] and its scientific name is *Grus Leucogeranus.* This beautiful bird is a winter visitor of Keoladeo wetland (Plate 6). It is a highly endangered migrant from Siberia, which has brought international fame and attention to this wetland. This species has two groups of population;

1. Which breeds in eastern Siberia and spend winters in China.
2. And the other which breeds in western Siberia and winters in India (Keoladeo National Park Wetland) and Iran (Sat-Al-Arab Lake).

Population of the crane in eastern Siberia is near about 2000 and is more than western Siberia. But the cranes in eastern Siberia have faced problems in last few years because of frequent droughts in its major wintering ground, ***Poyang Lake (China).*** There is also an imminent danger of a dam on the Yangtze Kiang River where this lake is located in the basin of the river.[8]

The crane population in western Siberia wintering in Iran fluctuated between 11 and 15 in 1980s to none and 6 in 1990s. On the other side, the wintering population

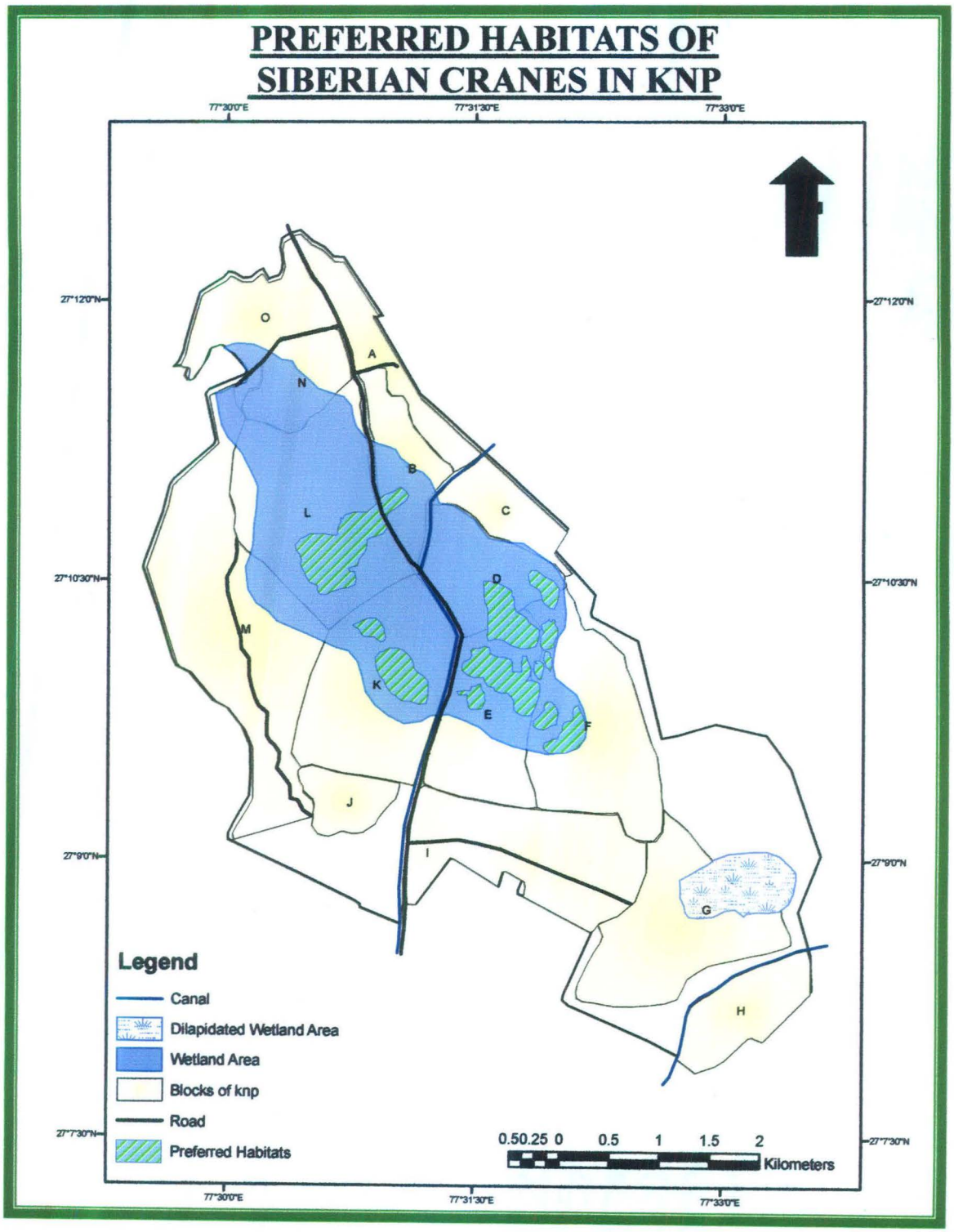
PREFERRED HABITATS OF
SIBERIAN CRANES IN KNP
77°30'0"E
77°31'30"E
77°33'0"E
27°12'0"N
27°10'30"N
27°9'0"N
27°7'30"N
O
A
N
B
C
L
D
M
K
E
F
J
I
G
H
Legend
Canal
Dilapidated Wetland Area
Wetland Area
Blocks of knp
Road
Preferred Habitats
0.50.25 0 0.5 1 1.5 2
Kilometers

Fig. 3.7

coming to Keoladeo wetland, India has plummeted in last three and half decades from 200 to none in years 2003-06. This is visible in figure 3.8.

Journey of these cranes starts from the cold and harsh environs of western Siberia to spend winters in relatively warmer and more hospitable climate of Keoladeo. These cranes stop at several staging areas for rest, like Ab-e-Istada Lake in Afghanistan. They land at last in Keoladeo National Park in India after covering an arduous journey spanning more than 6400 Km.[9]

The Siberian crane feeds mainly on tubers of sedges, rhizomes of water lilies, rushes and insects from the marshes inside the Park, in 10 cm to 40 cm deep water. The digging behaviour is very interesting to observe. With its soft red beak, it first pulls out the surface soil down to 3-4 cm, to locate and extricate the tuber and rhizome. The food item is washed by splashing in water and then swallowed. While one digs, the other loyal partner keeps watch for any possible danger. Their habitat has been adversely affected by the overgrowth of the weed, *Paspalum Distichum,* forming a thick mat over the marshes of the wetland. This not only affects their efficiency in digging and excavating the tubers, but also regeneration and abundance of the sedges.

Successive droughts after 1980, mainly 1985, 1986, 1987, 1999, 2000 and 2001 have also affected this species. These droughts created favorable conditions for the thick growth of grasses in the Park making it inhospitable to Siberian cranes. This forced them to leave the wetland in search of better abodes. In the process, probably, many were killed. The Siberian crane is facing a threat of extinction[10, 11, 12] because;

i. Its low productivity of 10 per cent to 15 per cent,
ii. The most arduous migration (approximately 6400 Km),
iii. Persecution during migration and
iv. Highly specialized food and feeding requirements.

These cranes migrate, and stop over at Afghanistan[13] which is a war zone. Apart from this, many nomads living there poach these amazing birds for food and recreation without knowing their great importance as a link through cold, temperate and sub-tropical climates.

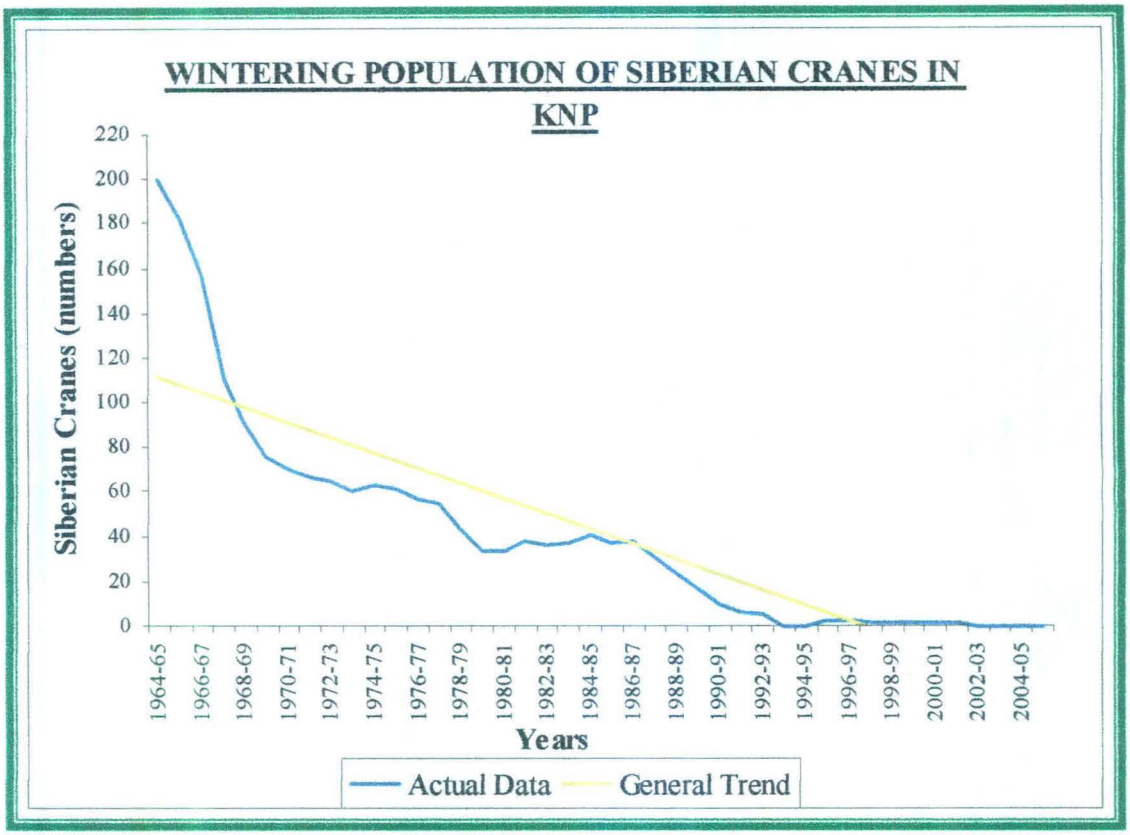

Fig.3.8

Source: World Wide Federation Office, Project Manager, KNP, Bharatpur, Rajasthan

A look on figure 3.8 clearly indicates the fact that there has been a remarkable decline in the number of Siberian cranes coming to Keoladeo wetland. This bird can be treated as the representative of all the immigrating birds, in the past 40 years. This alone illustrates the very problem of deterioration of the wetland. In 1964-65 the number of Siberian cranes coming to KNP recorded to be around 200 that dropped down to nil in years 2003-06. It has shown a continuous declining trend. This could well be related with increasing atmospheric temperature and decreasing rainfall. Thus the number of birds visiting the wetland truly reflects the changes occurring in the wetland.

3.2.3 Protection Drive for Siberian Cranes

As stated above, this star attraction of Keoladeo wetland is facing great danger of extinction. Its numbers have steadily declined over the past 50 years, and it is uncertain if these will again visit Keoladeo wetland. So, many measures have been taken to augment

and rehabilitate this crane by the Central and the State Governments, World Wide Fund, SAKON, BNHS and many other NGOs. One of these measures is 'rehabilitation by introducing captive reared chicks in Siberia and KNP, India'.[14]

Confirmation of the migration route is a pre-requisite to take any protection measures for this crane. Steps are being taken by various national and international agencies to achieve this. With the help of International Crane Foundation (ICF), Wisconsin, USA and a team of Russian scientists, 'Isolation-Rearing and Bird-Ringing programs' were run for the protection of this rare specie in years 1992 and 1993.

Isolation-Rearing technique in aptly known as 'costume rearing' and was developed by Dr. Robert Horwich of International Crane Foundation (ICF).[15] This program involved 'rearing'(nurturing) of crane chicks by human foster parents, clad in crane costumes, who also try to produce natural conditions by using taped crane calls. The chicks were kept in vocal and visual isolation from human beings and their exposure to wild cranes was encouraged. 'Human fear' training sessions were given to the chicks to enable them to develop fear and aversion for humans, something that is inherent in wild cranes. But these chicks could not respond positively to the training and were unable to make theirselves fly and mingle with wild cranes. Thus, the mission got failed.

During the 'bird-ringing program' radio transmitters were attached to two cranes to track their migratory route by satellite. These were marked with metal rings in their legs also. Their entire migration route was mapped from India across the Hindu Kush to northern Russia. An idea was to know about the hurdles and hazards that they might come across on their way.

3.3 VALUES

Water being a vital component of life support system, human civilization from its very origin has been associated with water sources. Age old settlements in different parts of the world evolved near rivers and lakes. The array of wetland values includes ecological, functional, economic, aesthetic and cultural values.

KNP also is a wetland which displays a large assortment of valuable assets which must be utilized instead of being exploited. The values of this wetland can be divided into three parts:

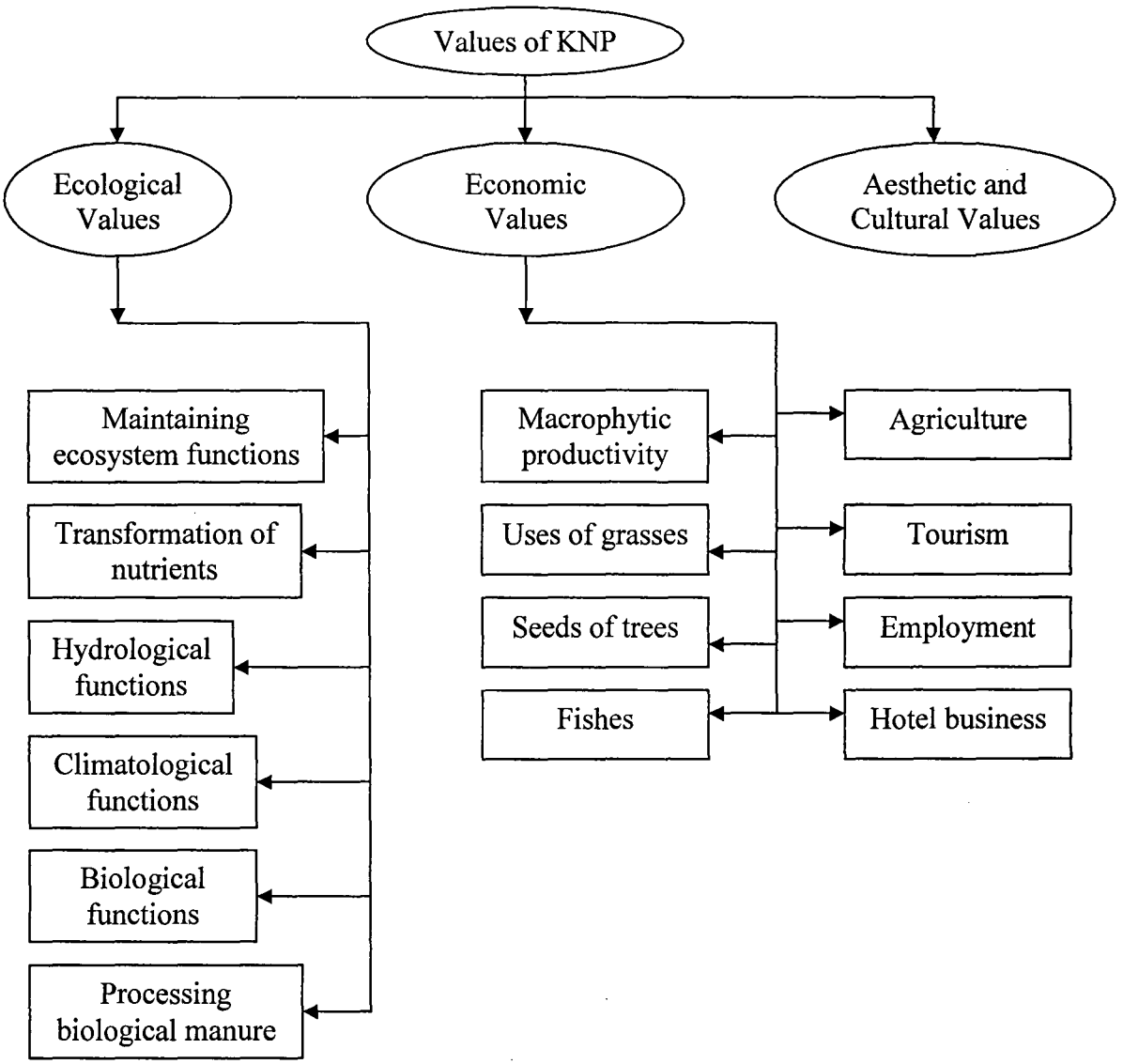

Fig.3.9

3.3.1 ECOLOGICAL VALUES

Ecological values of KNP wetland are derived both directly and indirectly from its resources and functions.

Maintaining Ecosystem Functions

The wetland of KNP plays a critical role while contributing a lot in maintaining the ecosystem. This wetland is a highly productive system with the nutrient load received from Gambhir and Banganga rivers through Ajan bund. It is found to be three and a half

times more productive than the average natural terrestrial system[16] and the total production is more than that in rain forest.[17]

Storage, Processing and Release of Nutrients

The wetland of KNP stores, processes and releases nutrients from terrestrial systems, which finally flow down to the agricultural land in the villages surrounding the park. And hence, it is considered as a link between land and water.

A wetland is considered to be one of the nature's magnificent processing factories. A wetland acts as a sink of nutrients which are trapped in peat. Its role is very significant in reducing the green house effect by utilizing carbon dioxide during primary production.

Hydrological Functions

This refers to the vital function of flood control and ground water recharge and discharge. One of the major objectives of the erstwhile rulers of Bharatpur in converting this wetland into a permanent waterfowl reserve was to protect the town from frequent deluges. It was a natural depression capable to store a large quantity of water.

Flood water infiltrates through soil to recharge the aquifers and discharges into wells and the wetland. While moving down to the aquifers, water is purified at two levels. First at the surface level by flowing through the vegetation which absorbs some of the pollutants and later it is filtered by the soil. A canal *(dakan mori)* also passes through the Park and reaches the villages to the south. It provides water to the nearby areas for drinking, irrigation and other purposes.

Climatological Functions

Such functions provide an indirect benefit to the people. The presence of water for a long period increases humidity and stabilizes temperature. The climate of Bharatpur town is moderated owing to the presence of Keoladeo wetland. Whereas, the town Dausa, 110 kms to the west, faces more arid climate than Bharatpur. Increased primary production in and around the Park and various biochemical processes release oxygen and many other gases to the atmosphere creating a healthy environment. The woodlands

around the wetland act as a windbreak and provide protection from storms to the neighbouring villages.

The biodiversity of the Park is high due to the presence of the wetland. It is apparent with the variety of species of flora and fauna present inside the Park. This wetland is refuge for many resident and migratory birds including the highly endangered *Siberian Crane.*

The function of the Park as a gene pool or a gene bank needs no explanation. The wild species of rice *Oryza rufipogon,* water lilies *Nymphaea,* and *Trapa,* probably with disease resistant genes, add to the importance of the Park.

Processing Biological Manure

The wetland with its woodlands contains many species of flora and fauna. There are ungulates and feral cattle in large numbers in the Park which spread their dung in the whole Park while grazing. Mostly the dung is found in heaps and is disintegrated by worms and very small insects that can be hardly seen by naked eyes. Many compost pits have been made by the Park administration to dump this material. When the disintegrated dung is mingled with crumbled leaves, water and soil, it develops into 'naturally processed biological manure'. This manure helps to maintain the high productivity of the Park. On the other hand, on the demands of dwellers of the surrounding villages and environmentalists, the villagers are allowed to collect this natural fertilizer for past fifteen years.

3.3.2 ECONOMIC VALUES

Calculating an approximate economic value of a wetland is difficult and has rarely been attempted in the tropics[18]. The values useful for environment, although not expressed in monetary terms, are of special significance. It is a fact that is being increasingly realized by people.

Macrophytic Productivity

Productivity of emergents in a tropical wetland is higher than that of tropical forests. Aquatic plants support a variety of wildlife. Keoladeo National Park is a shallow wetland covered to a large extent by macrophytes. The productivity of macrophytes is so

high that it may result in deterioration of wetland area unless these are removed adequately. The net aboveground productivity was a maximum of 35 tonnes in 1986[19] and 48 tonnes in 1999[20].

The removed biomass (water hyacinth and grasses) is used as cattle feed. This, in turn, provides other benefits such as dung, used not only as manure but also as fuel in the form of dry dung cakes. This further reduces pressure on the Park for fuel.

Use of Grasses

Grasses such as Khas *(Vetiveria Zizanioides)* and Munj *(Desmostachya Bipinnata)* grow in the uplands of the Park which are flooded for a short duration. Khas grass encroaches even into wetland areas, mainly along the margins. It is used for extracting vetiver oil (khas) from the roots. The species found in KNP is of a better quality with higher yield[21]. The culms of this grass are used as fodder, for thatching and other economic purposes. *Desmostachya* is more fibrous and used mainly for making ropes. Other reeds with larger culms are used for making chairs and other furniture items.

This value is worthless in the Park since the ban was applied on grazing and picking grasses in 1981. Presently, the villagers are allowed to pick the grasses only in the months of summer.

Tourism

'A wide natural beauty packed with dense trees (Acacia, Kadam, Zyayphus, Neem, Albizzia, Julie flora and a lot others), resident and migratory birds flying, nesting and searching food in the shallow lakes of the Park, lazy pythons lying in sun in winters, fluttering butterflies, screaming heronry over the tips of the trees, jumping Chitals and Black Bucks and dim fog in the mornings of January present such scenario that can be compared only to a heaven on earth'[22].

The tourists coming to the Park never forget this collective beauty scattered in a small area of just 29 sq km. Visitors to the Park have been increasing. Their numbers have fluctuated, in past two decades, with the abundance of migratory waterfowl and the colonial breeding fish eating birds. Endangered Siberian cranes have also been as the main attraction for visitors. After the mid 1980s, the numbers of tourists visiting in a year averaged ninety thousand [23].

The revenue earned through entry fees and transport facilities inside the Park itself is quite appreciable. About 3/4 of the total revenue collected from tourists is spent over the maintenance of the Park and its Lakes. The local guides and rickshaw-pullers earn a sizable income in the peak season and so do the local food vendors.

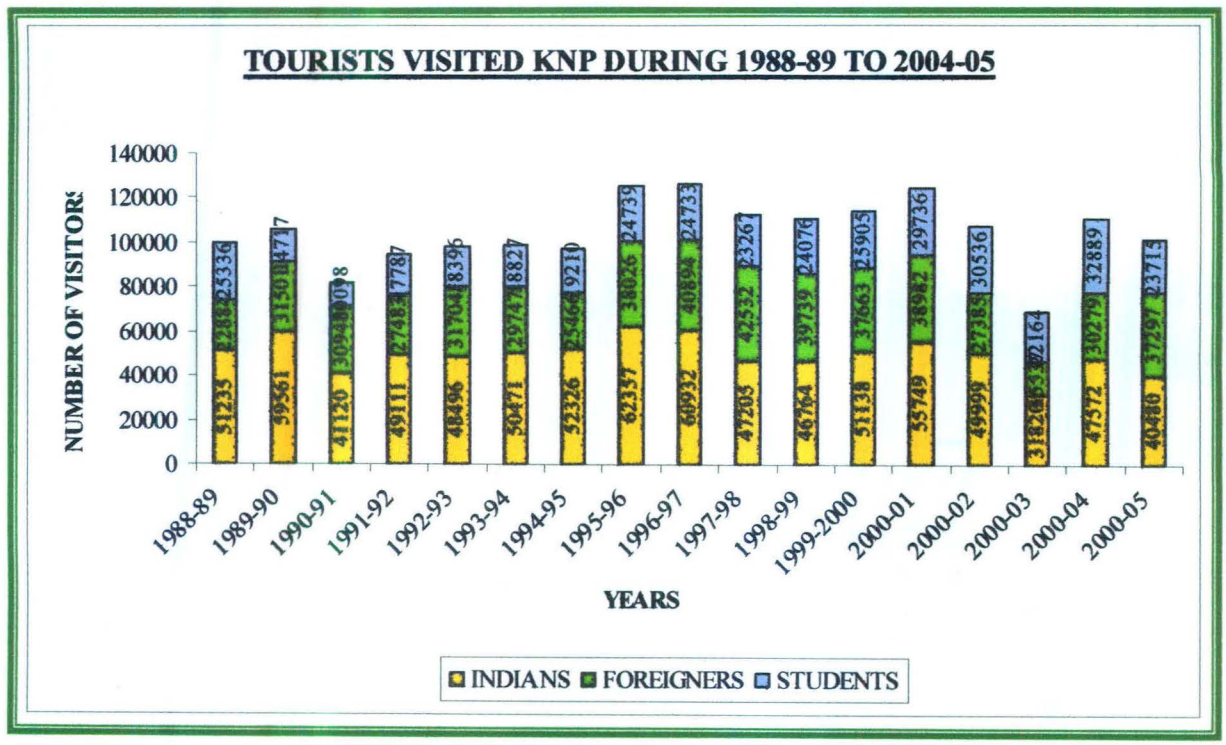

Fig. 3.10

Source: Forest Department, KNP, Bharatpur

Number of tourists visiting the Park is usually associated with the major attractions of the Park like Siberian cranes, Sarus cranes, Herons, Storks, pythons etc. The total number of tourists including Indian, foreigner and students has varied with concentration of birds in the park. Maximum number of tourists visited during 1995-97 and in 2001. Number of tourists was least in 2002-03 due to sudden fall in the migration of Siberian cranes with other birds. About 80 per cent of total tourists visiting the Park every year visit in the months of winter from mid of November to the end of February.

There are about 122 rickshaw-pullers in KNP to serve the tourists. Most of them are illiterate and very few are educated up to junior high school and high school. But it's very strange that all of them deal with their customers in 'English language'. They are

being registered by the Park administration since 1981-82. Earlier there was a registration fee of Rs. 150 per season till year 2000. They earn most of their income during 4-5 months of tourist season.

Tourism has not only financial implications, but also an educational value. The frequency of student groups visiting the Park is very high.

Hotel Business and Market

Keoladeo National Park has created lots of opportunities for the locals of Bharatpur to earn capital by providing homely services to the tourists visiting Keoladeo. There are approximately 30 hotels in a radius of four km from KNP. They all do decent business in the tourist season according to the services provided to the guests. These hoteliers have contributed a lot in developing the villages surrounding KNP. The reason behind this is that most of the hoteliers and the employees are dwellers of these villages.

The local market of Bharatpur town also makes a big sum of money. Thirty per cent of the visitors are foreigners and most of them are keen bird watchers, nature lovers and photographers. So, the camera shops, film developing labs, bicycles on rent and restaurants etc. make profit during the tourist season in KNP.

And, above all KNP also helps in earning foreign exchange with local revenue that helps in strengthening a country's economy.

Fishes

Tonnes of fish are devoured by thousands of birds in the Park and also collected by the locals. Yet, a sizable quantity dies and decomposes, thereby adding to the eutrophication of the wetland. Since 1982, fishing by locals was banned but it was later allowed on contract basis which earned revenue to the administration.

Availability of fish is in accordance with the total water availability. During pre monsoon period when water level goes down, fish availability is also recorded low. While in the post monsoon period when water starts increasing in the lake and till monsoon retreat, amount of fish in lake is very high. In the March, when birds start their return journey, the availability of fish suddenly increases.

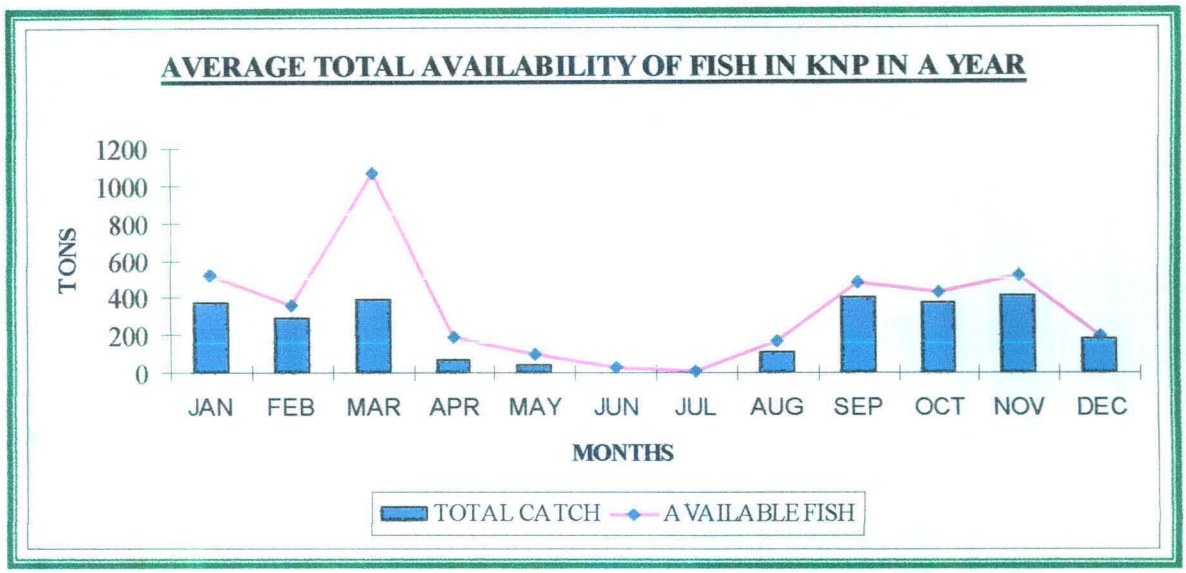

Fig.3.11

Source: Forest Department, KNP

Agriculture

The water table of the surrounding area is conditioned by the level of water in the wetland. Agricultural productivity depends on water and soil moisture availability, and hence, the presence of the wetland helps to improve the economy of the region. Acacia, Kadam, Zyayphus, Neem and Albizzia are collected from the Park for raising seedlings for social forestry operations.

3.3.3 ASTHETIC AND CULTURAL VALUES

The spectacular sight of the variety and abundance of birds is a joy to the millions of people visiting this Park. For many the pleasure remains in shooting with a camera, capturing numerous delightful and interesting scenes such as thousands of ducks landing. The variety of plants and flowers are an enchanting sight.

Keoladeo wetland is virtually a 29 sq km oasis amidst crop fields, and settlements, including a town with nearly three lac twenty thousand inhabitants just two km away from the Park entrance. The road up to five km inside the Park from the main entrance is heavily crowded in the morning hours by people coming here from the city for fresh air and relaxation.

Life in the whole region is centered on the benefits accumulated directly or indirectly from the wetland-agricultural practices, life styles and food habits. All are influenced to some extent by this wetland. These factors have great impact on the culture and tradition of the region.

Above discussion clearly indicates the fact that every wetland is associated with certain potentials for which it is valuable to human beings. To extract these values, humans, intentionally or unintentionally, exploit this resource to the extent that it starts degrading. Similar is the case with Keoladeo wetland. Presently it is facing a number of problems those have threatened its existence. These include environmental contamination, siltation, insufficiency of water, brutality of climate etc. These problems have already started to show their alarming consequences. The water spread area of the wetland has started to decline and will continue to do so if strict measures are not taken immediately. Siberian cranes, which are the centre of attraction of the Park, are no more visiting the Park in due numbers. In the past few years not even a single Siberian crane visited the Park. This itself shows the deteriorating conditions of the park.

The Park also possesses some unmatched values like playing a vital role in environmental functioning, providing food, fuel and fodder, tourism, providing employment to surrounding population etc. so this is really important that these values of the Park are utilized to an optimum level and that too sustainably. This will not only maintain the ecosystem of the Park but also make these values available to the coming generations.

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Chapter 4

IMPACT OF HUMAN INTERFERENCE ON KEOLADEO WETLAND

Wetlands are one of the most precious natural resources on the earth. But these are facing many problems. Some of these problems are physical and related to environment. But the present poor status of wetlands, all over the world, is largely the result of inappropriate human activities. Wetlands in developed countries are facing danger because of the rapid development, industrialization and urbanization. People there are destroying wetlands for acquiring more land to establish new industries or urban areas. At places, this has resulted into vanishing of wetlands.

Unlike developed nations, the economy of developing and underdeveloped nations is mainly based on primary activities. These are linked directly to land, rivers, forests, lakes and wetlands. So it is quite obvious that wetlands, here, are in danger because of over burden of dependence for food, fiber and fodder. Thus, these are over exploited by the people living around. This can be described as 'the impact of human interference on wetlands'.

It has been said by Turner and Kerry that wetlands as ecosystems have been one of good cradles of nature. Wetlands, whether tropical or temperate, have successfully maintained the environment freshness by being a good purifier of nature. There is a 'give and take' relation between living beings and nature. It is simple to understand with Figure 4.1:

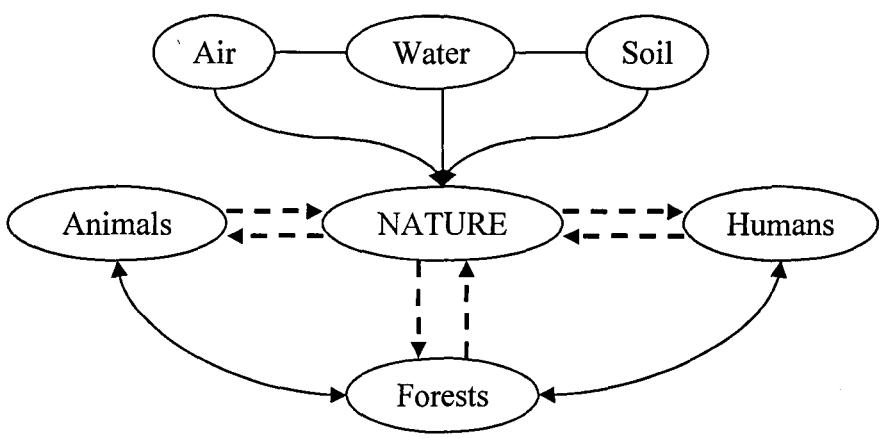

Fig: 4.1

But it seems that human beings have taken this relationship for granted and this link has shown a destructive trend in the cycle. Humans keep on exploiting all the resources of nature till these cease.

Human interference is becoming one of the major problems responsible for degradation of wetlands. So, it is important to have a look on the demographic structure, living standards, working conditions, social setup, literacy, basic needs etc. of the settlements deriving benefits from the area. Apart from that, the dependence of people on wetland and its importance in their lives are also the key factors to analyze the problem.

The present status of Keoladeo wetland is not different. People living in the surrounding villages and town have modified and exploited Keoladeo since the very beginning. Villagers exploit the Park for grazing cattle, collecting fuel wood, illegal fishing, splitting canal *(Dakan Mori)* water for irrigation, honey collection etc. This sometimes becomes hazardous for the Park like the method practiced for honey collection has many a times resulted into forest fire. It can be stated that Keoladeo wetland is more affected by human beings than by the nature. It is one of the few wetlands which suffer and pay for irresponsible and careless conduct of the local society. The miscommunication between administration and the locals has led to various controversies in the Park. 'Look after your small profits and forget the long term profits' seems to be very true for the society concerned to it. The problems created by the locals, the Government, the Park administration and other agencies need to be analyzed in an appropriate manner to evolve proper conservative measures. To assess the impact of social interference, it is essential to;

a) Have an appreciation in terms of area, density, population growth, literacy, economy etc. of the villages those are directly dependent on Keoladeo.
b) Inquire into the benefits which are fetched by the villagers from Keoladeo.
c) Controversies over water supply – role of Government, media and other agencies.
d) Results and current status to know inferences of these controversies.

4.1 VILLAGES SURROUNDING THE PARK

The history of Keoladeo National Park presents a picture of man's involvement since the beginning. Keoladeo has evolved from a temporary rainfed depression into a world famous waterfowl refuge. The cultural and economic activities of the villagers around the Park have played an important role in the modification of this ecosystem. The present study, although limited in scope, has been undertaken to gather information about

the general economy of these villages. It also presents the dependence of the villagers on the Park, and their attitude towards the conservation and exploitation of the Park.

The population of Bharatpur district was 21,01,142 persons while that of Bharatpur Tahsil which covers 908 km^2 was 3,72,876 persons in 2001. There are 21 villages and hamlets around the Park. On the basis of their apparent dependence on the Park, 10 villages, namely Jatoli Ghana, Barso, Ghasaula, Bahnera, Malaah, Ajan, Aghapur, Chaukipura, Chak-Choba and Darapur have been selected for the study. These ten villages are situated very close to the Park and are heavily dependent on KNP.

As far as area is concerned, 'Aghapur' (612 hac.) is the largest while 'Chak-Chauba' (79 hac.) is the smallest village. 'Ajan' occupies a large area of 240 hectares but is less populated. It lies in the catchment of Ajan reservoir which has been named after it. In the times of monsoon, the village usually gets flooded. The villagers are settled on the uplands and the lowland is used for cultivation.

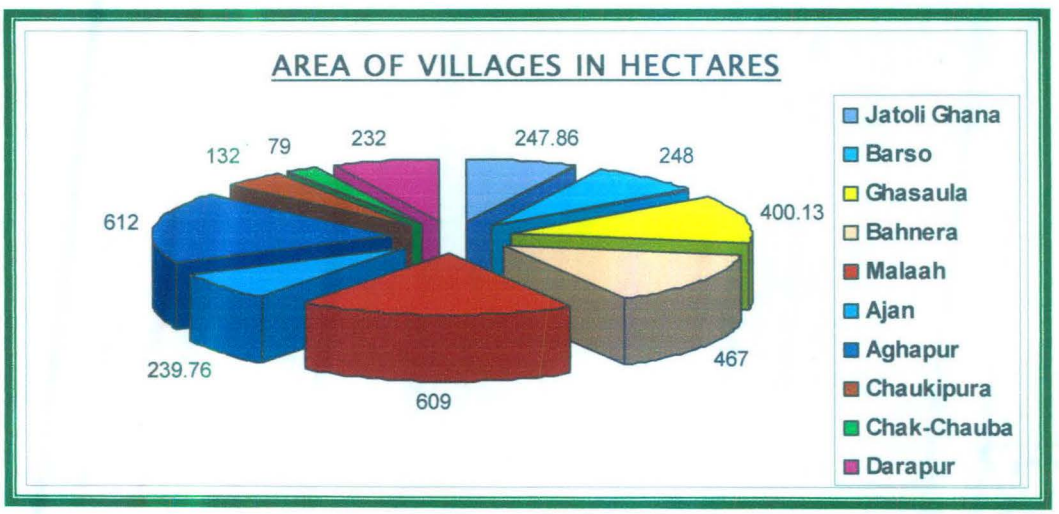

Fig: 4.2

Source: District Census handbook, 2001, Bharatpur, Govt. of Rajasthan

The village society is divided on the basis of the casteline and there are segregated areas within the village. Dominant castes in terms of numbers are Jat, Gujar, Jatav, Banjara and Brahmin. The families are male dominated. Average family size is eight members per household. Average literacy rate is about 48 per cent [1].

Malaah has been the largest village in terms of the size of population since 1951. 'Ajan' and 'Chaukipura' are among the least populated villages. A look at the growth rates of surrounding villages show that population has increased substantially in most of the villages. Though, 'Ajan' and 'Aghapur' villages had negative growth in 1991-2001 and 1981-91 respectively. Contrary to this, 'Ajan' is also the village that experienced maximum growth that is 60 per cent followed by 'Chaukipura' with 55 per cent in 1981-91. 'Ghasaula' village has maximum growth approximately 40 per cent in 1991-2000. Since 'Ajan' lies in the catchment of Ajan bund, it faced heavy floods in 1995, 1996, 1998 and 1999. This led to displacement of population towards highland causing decline in growth rate.

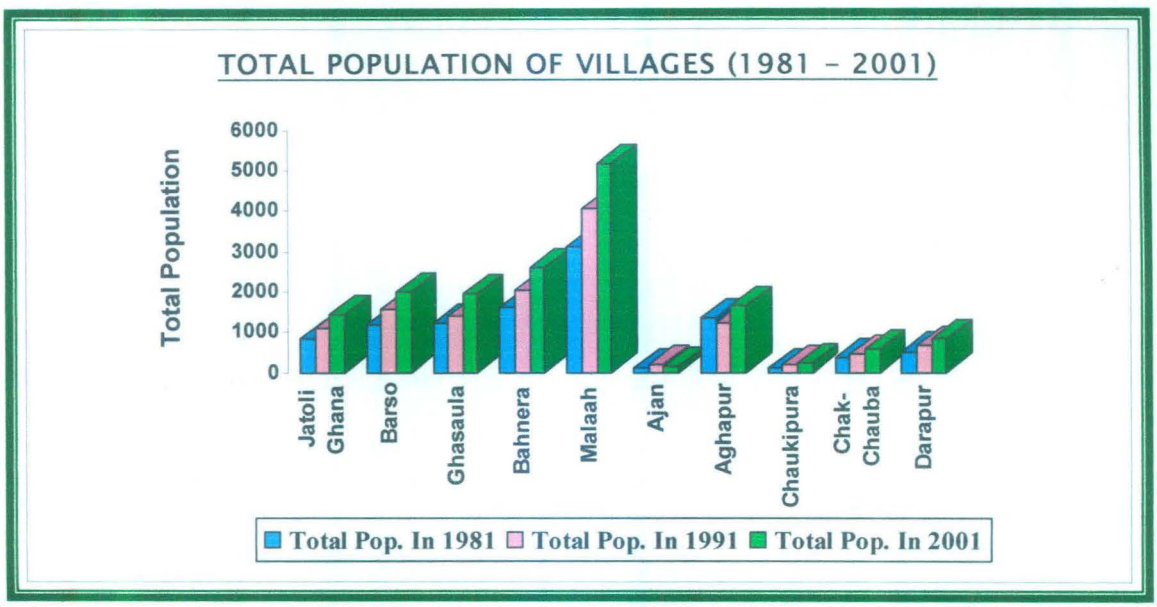

Fig: 4.3

Source: District Census handbook, 2001, Bharatpur, Govt. of Rajasthan

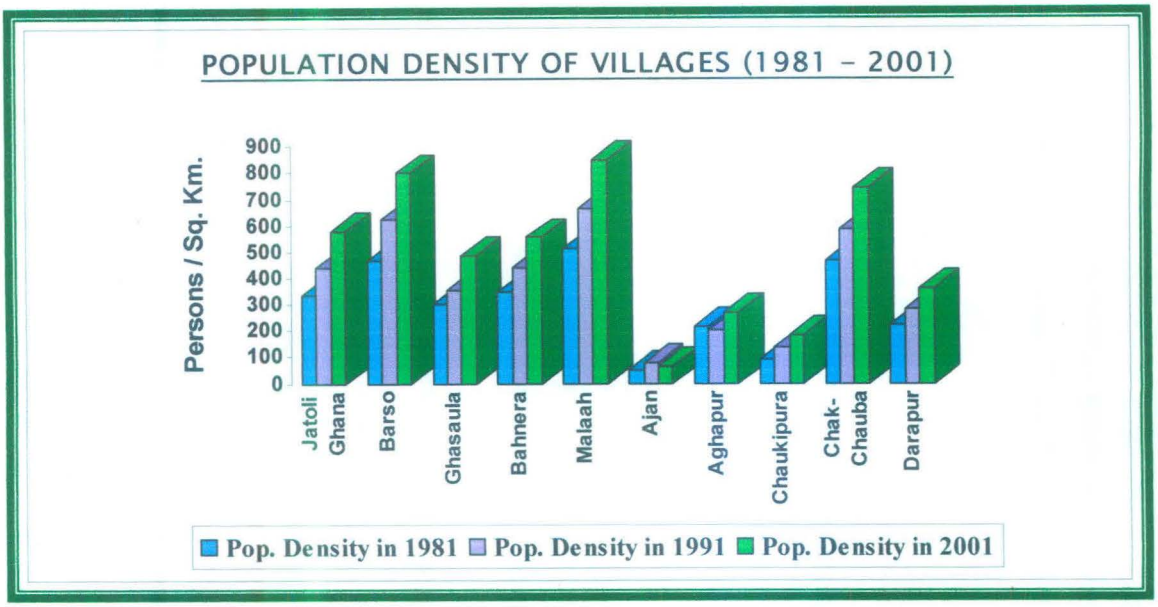

Fig: 4.4

Source: District Census handbook, 2001, Bharatpur, Govt. of Rajasthan

Growth rate of population in 'Ajan' and 'Aghapur' showed a decreasing trend in last two decades. This was probably a result of consecutive floods in the catchment area of Ajan reservoir which made villagers to move towards safe places. But this could not make them to leave their agricultural lands. The land of these two villages is the most productive land in the area because of the comparatively higher water table. Thus, it yields good production for the farmers.

Table 4.1

VILLAGES	Total Pop. In 1981	Total Pop. In 1991	Total Pop. In 2001	Growth Rate (1981-1991)	Growth Rate (1991-2001)
Jatoli Ghana	831	1098	1433	32.13	30.51
Barso	1160	1553	1985	33.88	27.82
Ghasaula	1203	1406	1952	16.87	38.83
Bahnera	1610	2049	2595	27.27	26.65
Malaah	3106	4055	5183	30.55	27.82
Ajan	114	183	155	60.53	-15.3

Aghapur	1334	1243	1648	-6.82	32.58
Chaukipura	118	183	238	55.08	30.05
Chak-Chauba	370	462	588	24.86	27.27
Darapur	512	653	842	27.54	28.94

Source: District Census handbook, 2001, Bharatpur, Govt. of Rajasthan

The villages are in a state of underdevelopment to gradually developing. The surroundings are usually unhygienic mainly because of cattle-sheds and absence of proper sanitary facilities. The living conditions of the villagers, thus, need to be improved.

The provision of primary education is in five villages while that of secondary education is only in two villages. Only one school is of senior secondary level. Most of the girls and boys have to go to Bharatpur town for further schooling and higher education.

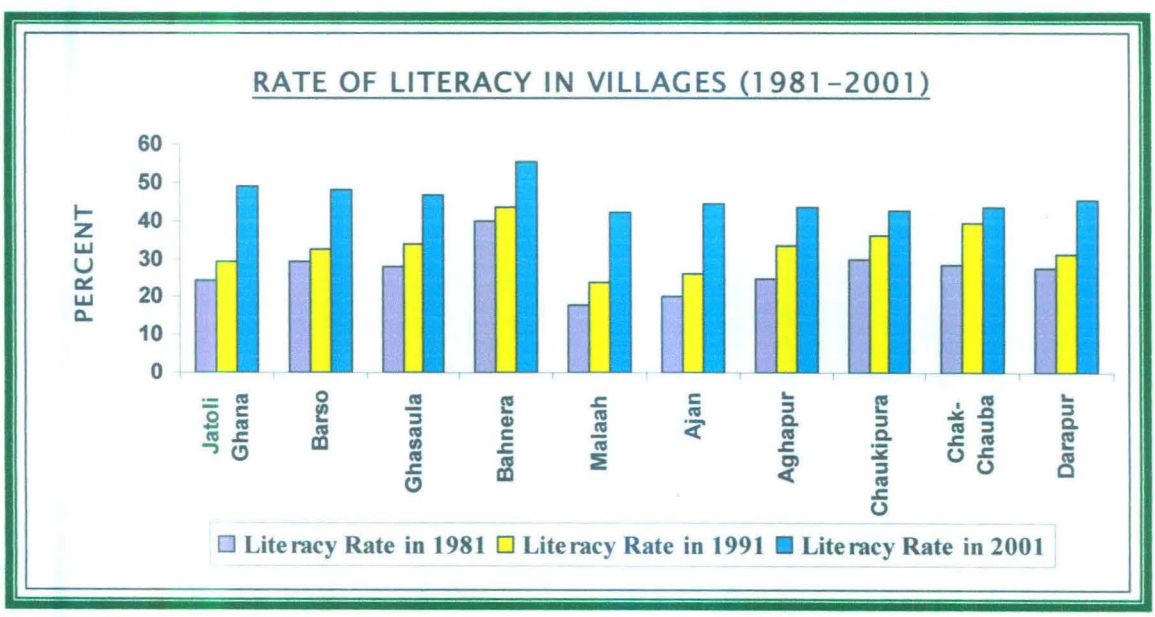

Fig. 4.5

Source: District Census handbook, 2001, Bharatpur, Govt. of Rajasthan

Table 4.2

VILLAGES	Literacy Rate in 1981	Literacy Rate in 1991	Literacy Rate in 2001
Jatoli Ghana	24.31	29.51	49.10
Barso	29.40	32.39	48.26
Ghasaula	28.10	33.85	46.67
Bahnera	39.75	43.39	55.57
Malaah	17.19	23.63	42.12
Ajan	20.18	26.23	44.52
Aghapur	24.89	33.63	43.63
Chaukipura	29.66	36.07	42.44
Chak-Chauba	28.38	39.40	43.71
Darapur	27.34	31.09	45.25

In most of the villages, agriculture is the major source of income for the villagers. Livestock contributes substantially to the income of Darapur, Ghasaula and Malaah. In some villages, agriculture with livestock gives boost to the total income. Some of the families in a few villages are involved in tertiary and quaternary activities. Nearly 100 rickshaw–pullers earning in Keoladeo are dwellers of these villages.

In recent years there has been a change in cropping pattern of the villages. Food crops like wheat and pulses are being replaced with mustard and rye. This change has become prominent, especially after successive droughts in past 15 years. It is to be noted that the requirement of water for 'mustard' and 'rye' is much less than that of food crops and other cash crops. Villagers are also inclined towards horticulture since last decade. As agricultural activities are seasonal, the alternative occupation of many of the families is livestock rearing. Buffalo, cow, goat and sheep, in the descending order of abundance are the main livestock species in the villages.

The major fuel used for cooking is cattle dung which is used extensively in eight out of the ten villages under study. In the villages where agriculture is the major occupation, agricultural wastes are used for fuel. Wood is also a minor supplementary source of fuel in the villages. After the year 1982, the grazing was banned inside the

Park. Most of the villagers involved in cattle rearing switched over to cultivation after that.

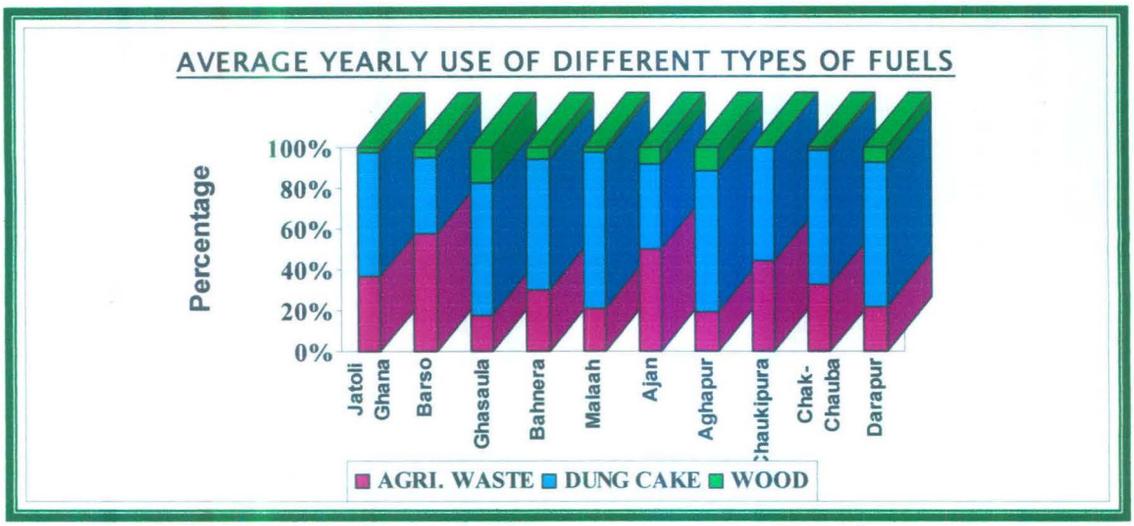

Fig.4.6

Source: Department of Animal Husbandry, Bharatpur, Government of Rajasthan

4.2 PARK IN THE LIVES OF VILLAGERS

Maharaja Suraj Mal, the then ruler of the Princely State of Bharatpur, established Keoladeo to protect Bharatpur town from the consecutive floods [2]. Keoladeo Lake was modified considerably in the late 18th century by regulating water from rivers Banaganga and Gambhir through a system of canals and dykes. Maharaja appointed near about 250 persons to look after this swampy reserve forest. These people formed small settlements around it which later became villages [3].

Later the area was developed into a duck shooting reserve in 1899 by prince Harbhanji of Morvi State in Gujrat. He was appointed the Administrator of Bharatpur at that time. The Prince was inspired by the duck shoot reserves that he had visited in England. He got bunds and dykes constructed between 1850 and 1899 that increased the water holding capacity of the depression. The entire area was flooded for the first time in 1901 with water from Ajan reservoir [4].

The villagers living around Keoladeo have been continuously maintaining a natural interaction with the Park for last 250 years. They are dependent on the Park for a

lot of small but essential needs of life. The profits, directly or indirectly, fetched by the villagers from Keoladeo are mentioned below:-

1. The villagers obtain fodder for their livestock from the Park. Villagers use to leave their cattle for grazing in the grasslands.
2. Farmers have been dependent on the park for irrigation water which they get from the feeder canals *(Dakan mori, Chiksana Canal and Sapan mori)* from Ajan dam.
3. Approximately 40 per cent area of Keoladeo is a wetland which is filled with water upto 5 feet just after the monsoon period. So, it also helps to maintain the water table high in the surrounding areas of the Park.
4. Poor villagers collect fuel wood for various purposes from the Park.
5. Villagers collect different grasses like Khas, an oily grass, and Munj for thatching material, rope making and handicrafts and honey and various medicinal plants from the Park.
6. Keoladeo National Park has provided many opportunities of work and employment for villagers. Many of them have been appointed in the Forest Department of KNP. A number of them are working as forest guards in the Park and a lot many are earning by being Guides. Near about 100 registered rickshaw pullers from these villages are earning approximately Rs. 3000 to 4000 per month from the tourists visiting the Park.
7. Villagers have been attracted by the opportunities of employment in the Park, so they send their children for higher education to achieve eligibility. Thus, KNP has helped the villagers indirectly in increasing literacy rate.
8. Keoladeo has helped to improve the economic condition of the villagers by offering many opportunities of employment.
9. Keoladeo is not only a place for tourist recreation and bird watching but also an important place for biological, zoological, ecological and social researches. Government and the Park administration also come to know about these problems through researches.
10. Keoladeo is a reserve forest spread over 29 sq. km area. It helps environmentally by attracting rainy clouds, producing more oxygen and fresh air etc.

Thus, it seems very true that Keoladeo holds a very important place for the surrounding villagers. It is also clear that these villagers are economically, socially, biologically, and environmentally benefiting by the Park. It is a visible fact that these villages have progressed with the grace of the natural bounty of Keoladeo.

4.3 CONTROVERSIES OVER KEOLADEO

Keoladeo National Park has been facing many controversies since 1980s and gradually seems to be defeated in the struggle of saving itself every year. Keoladeo has been exploited socially, economically, politically and ecologically, deteriorating it every year.

If we look back into history that is no longer than Indian Independence in 1947, we will see that it brought the first expression of discontentment and restiveness among the local population in relation to the Park. This was fuelled by demand for crop land and water for irrigation. Local communities clamoured to divert water of Ajan reservoir away from Ghana for the purpose of irrigation.

In view of the changing political climate and public unrest, the ruler (Maharaja of Bharatpur) decided to hand over Ghana (KNP) to the Government of Rajasthan. The Government, on the advice of the National Committee for Bird Preservation, India, notified it as a Bird Sanctuary in 1956. The rulers, however, retained hunting rights until these were withdrawn in 1965.

4.3.1 SOCIAL NON-COOPERATION

Social cooperation has always been recommended by environmentalists for the conservation of wetlands. But there has been a reverse situation with Keoladeo Wetland and National Park. Keoladeo has faced and is still facing a lot of problems created by the population living in the surrounding areas. People living far from this wetland have also equally affected it over the issue of water supply.

The villagers living around the park demanded the construction of a boundary wall around the park to prevent wild animals from destroying the crops in 1977. A masonry wall was constructed all around the Park between 1977 & 1981. It was done

after the written orders released by Smt. Indira Gandhi, the then Prime Minister of India[5]. But later this boundary wall was damaged at many sites by the villagers to enter their cattle for grazing.

The year 1982 was critical in the Park's history. In an effort to raise its conservation status, Keoladeo was declared a National Park. Rules of the Wildlife Protection Act, 1972, became applicable and the Forest Department was ordered to put an end to all forms of flora and fauna exploitation. In accordance to the provisions of the Act, grazing of livestock inside Keoladeo National Park was banned. This left a negative impact over the Villagers. Violence erupted in opposition to the ban. Seven villagers lost their lives. Trespassing through the Park was stopped and gates along the boundary wall were closed. This resulted into alienation of people from the park and its management. Ban on grazing caused significant economic loss for the villagers.

The concerned villagers argued in their favour that the Park had been open for grazing since it was constructed. Apart from that, they strongly and scientifically argue that their cattle should graze in the Park to prevent the wetland from turning into grassland. According to the villagers, the cattle provide small organisms for the birds to eat and also leave a large quantity of manure to make the land fertile.

The villagers are clever enough to exploit the resources of Keoladeo. They leave their cattle in the Park to graze through the big gaps in the boundary wall. And in summers when it is the time to grow fodder in the fields for cattle, they raise vegetables or some cash crops.

The occasional breakage of boundary wall for accessing to collect fuelwood and minor forest produce, extraction of grass in non-permit seasons, illegal collection of honey, pilferage of timber, grazing of cattle, illegal fishing, and use of the Park as a thoroughfare without permission are among the common violations that the Park suffers for and people are at times penalized for this.

Apart from that, the villagers defied the Park Authorities by leaving their useless diseased and old cows into the Park by physically lifting them over or breaking the boundary wall. Presently, there are approximately 1100 to 1500 old and diseased cows in the Park as feral cattle [6].

The biggest problem created by the villagers and farmers is that they many times steal the water supplied to the Park from Ajan reservoir. In the past few years, farmers have diverted water from two of three streams which once flooded the wetland, leading to a drop of more than 50 percent in the number of birds arriving to the Park [7].

Except some hoteliers and environmentalists, most of Bharatpur's local population, though aware of the situation, is not worried about the deteriorating condition of the Park. Non-popularity of tourism sector may be a reason behind it. However, if the Park is subjected to a long term water shortage it will certainly lose both biodiversity and tourism. It will also jeopardize Rs 5 crore it earns annually, apart from losing genetic diversity – something that cannot be easily valued [8].

There are two dimensions to the issue of conflict over water for Keoladeo National Park. These are – the conflicts raised by the villagers living around the Park and the conflicts raised by the people of Karauli district benefited by **Panchana dam**. Both the issues have been highlighted in media, but the second one has been more persistent within Bharatpur district and was given more importance as it was profitable for politicians. The first and older dimension has been the conflict over water in Ajan reservoir. Every year, water allocation for local farmers is an issue of contention. Every year, the Park Administration has to lobby the State Irrigation Department for their quota of water from the reservoir. Description of the second dimension is as follows:–

Panchana Dam Conflict

There were originally two principal sources of water to the Park and the surrounding agricultural land of Bharatpur – the rivers Gambhir and Banganga which fed water to Ajan reservoir. However, the Banganga river dried up several years ago as a result of catchment deforestation and water diversions, leaving the Gambhir as the sole water supplier.

Panchana dam was constructed on the river Gambhir in district Karauli, Rajasthan in 1991. It was constructed to mitigate high floods and fulfill the irrigation needs of the local farming community. Later on gates were installed on spill way of the dam in the year 2003. The dam is approximately 100 km from Keoladeo. Live storage of

the reservoir is 52.65 million cubic meter (mm^3). Its catchment area is 31 km^2; the dam itself being earthen, with full reservoir level (FRL) at 258.62 m.

The second dimension of the whole conflict surfaced in the post-monsoon season of 2004. This had to do with the demands of upstream agriculturalists. These are the farmers in the command area of *Panchana* reservoir, which irrigates about 35 villages over a gross command area of 11,172 hectares. There is no major difference in the demands of the two groups of the farmers, other being the farmers in the command area of Ajan reservoir.

The latest conflict developed in August 2004, after consecutive years of low rainfall. The agitation among the concerned farmers was inflamed by the decision of a Rajasthan State Government Committee headed by Chief Minister Vasundhara Raje to release 8.15 mm^3 volume of water from *Panchana* reservoir to Keoladeo. That time the reservoir was having only 35.7 mm^3 water.

Farmers from the command area of *Panchana* reservoir protested the release of water for Keoladeo in September 2004. Men and women pitched tents on the dry riverbed below the dam and dared the Irrigation Department to release water. They argued that *Panchana dam* was constructed for irrigation in Karauli district and the rights to use this water remain with dwellers of Karauli district only. So, they should be given the whole water stored in the reservoir for irrigation. The Vasundhara Raje Government reversed its previous decision leaving Keoladeo to another dry year [9].

4.3.2 ROLE OF GOVERNMENT, POLITICIANS AND MEDIA

As far as the role of State Government over Keoladeo and *Panchana dam* conflict is concerned, it always seems to be in soup. The State Government still doesn't look in the condition to resolve the matter by suggesting some conservative methods. Just after the rebellion raised by the agitated farmers of Karauli tehsil, it reversed the decision of supplying water to Keoladeo in a few days. The Government promised the people in the High Court of Rajasthan to make some other possible ways and plans to supply enough water to KNP. Government is still unable to sort out the problem after two years of the conflict.

The Central Government is never seemed to be interested except giving it the status of a National Park and help to get some financial supports from UNESCO and World Bank. It has never been able to help in resolving the problem of providing sufficient source of water to Keoladeo National Park.

Local and state level politicians have made Keoladeo National Park a political issue by blaming the ruling party for the acute problem. But no politician seems to be really devoted to resolve the matter. One of these politicians, Bhawani Singh Rajawat, parliamentary secretary of ministerial rank, alleged that farmers from Karauli have been instigated by local Congress leaders. While on the other side, Congress legislator C.S. Baid and his party colleague Harimohan Sharma blamed the BJP Government in the state for mismanagement of the whole controversy [10].

The reversal of the committee's original decision headed by the C.M. of the state, kicked off a spate of pro–park protests and media articles. Media was one of the responsible agencies for this positive effort. It brought the conflict to the masses of Rajasthan and different wild life organizations. Many organizations and individuals petitioned, agitatedly sat on *dharnas,* led rallies and held prayers for the life of Keoladeo wetland. These included the Tourism and Wildlife Society of India (TWSI) that petitioned the courts, the Ghana Keoladeo Natural History Society and Protect Keoladeo National Park Committee.

Rajasthan legislators also formed a green lobby group for the conservation of the environment and wildlife in the state. It exerted pressure on the Government to release water from *Panchana.* The TWSI launched a multi branched campaign demanding water. The matter is pending with the Central Empowered Committee (CEC) of the Supreme Court.

4.4 RESULTS AND CURRENT STATUS

Many organizations and committees in favour of Keoladeo National Park and media have alerted the common masses who are aware and feel their responsibilities towards the fragile ecosystems of wetlands and wildlife. Petition filed by the TWSI compelled the **Central Empowered Committee (CEC)** to solve the conflicts of Keoladeo National Park.

Following numerous complaints and after being approached by TWSI, the CEC held its first hearing on January 31, 2005. The Rajasthan State Government officials expressed their inability to release water due to irrigation commitments in Karauli district. The officials discussed the possibility of providing water from the river Chambal through a pipeline. It was planned to bring drinking water to Bharatpur city and also to Keoladeo national Park. The reason behind this inability was practical difficulties in release of water from *Panchana reservoir* to Keoladeo National Park. A short description is given below:-

- Reservation of water for Keoladeo does not exist in *Panchana dam reservoir.*
- Very high transit losses due to long distance between *Panchana* and Ajan bund.
- Sandy terrain of the river Gambhir in the way to Ajan bund after *Panchana* dam which soaks a huge volume of water.
- Even if transit losses are disregarded and water is released from the dam to the Park, it would lead to serious law and order situation, as already witnessed in September, 2004.
- Livelihood of about 9000 families living in 35 villages depends on agriculture based on *Panchana* waters.
- Increase of dam height for storing water for Keoladeo is not possible due to Karauli town coming under submergence.

Apart from this, the alternate plan of supplying water through a pipeline from the river Chambal will also possibly create some biological problems for the Park. As earlier mentioned, it is clear that the water supplied through this scheme will be treated for drinking purposes. It will be made available to 930 villages of Bharatpur district. If used for the Park, the chemically treated water, rid of organic matter, will make millions of fish fry and invertebrates die [11].

The next CEC hearing was scheduled on February 21, 2005. The State Irrigation Department was to appear before it with 'alternative plans' for supplying water to Keoladeo National Park. A three member special bench passed a notice following the submission of a 20 page report by the CEC on March 10. The Supreme Court directed the State Government of Rajasthan to release water to the Park from *Panchana dam* [12,13].

Though this makes the ongoing case temporarily redundant, there needs to be a policy that makes it mandatory for a certain amount of water to be set aside for the Park, particularly during dry years.

It is quite evident that social dependence is fairly large in case of Keoladeo wetland. The villages surrounding the Park are viably dependent on it for their basic needs. They graze their cattle, take water from canals, collect fuel wood, honey and grass etc. Moreover the Park has been a very important source of employment for the villagers. Despite bearing so much importance, Keoladeo has been facing many controversies. It is established that it is a rainfed wetland and usually subject to water crisis. Thus, the major one is regarding the supply of water. The people in the catchment of Panchana dam, that supplies water to Ajan dam reservoir, strictly disagree to provide water to Keoladeo due to their own interests. The Government and other politicians have been very prejudiced in the matter. And it has still not been resolved. The other major controversy is the irresponsible and careless attitude of the locals for the management of the Park. They have been exploiting the resources as if there is going to be no tomorrow. The local community is least bothered about conserving these resources. This all has led to the immense degradation of the Park. Even there is a risk that this site might lose its status of 'World Heritage', if this condition persists. So there is an urgent need to look into the matter.

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Chapter 5

MAJOR MANAGEMENT ISSUES IN KEOLADEO NATIONAL PARK

Human attitudes have been mostly ambivalent towards the existence of wetlands. It is clear from the fact that wetlands have been extensively exploited and ill-treated. These have been appreciated for tranquil beauty and simultaneously treated with contempt for causing diseases. Large areas of wetlands have been destroyed or modified by human beings, while numerous new wetlands have also been created, most often inadvertently. It is clear that wetlands are specialized ecosystems which perform important ecological functions. These have many ecological, socio-economic and cultural values. These values are highlighted by the fact that more than half of the world's population still depends on fish and rice. These both are the most important products of modified and intensively managed wetlands with virgin wetland areas.

Thus, there is a need to conserve the remaining wetlands and manage them properly. There is a need to enhance wetland functions and values corresponding with the goals of conservation. Since every wetland is a distinct feature in itself with specific characteristics, thus it also suffers from different problems. That is the reason these cannot be managed with a generalized conservation strategy. Problem identification is a prerequisite to conservation.

There are certain specific problems that have exclusively been faced by Keoladeo National Park. To mitigate these problems, it is important to understand pros and cons of these problems and consequently suggest conservation methods for the same. These aspects have been taken up as given below;

a) An introduction to conservation and its concept
b) Indian Scenario of wetlands to overview common problems faced by Indian wetlands.
c) Efforts made by Government to tackle the threats to these wetlands.
d) Management and conservation in KNP by identifying its peculiar problems and thereby finding the solutions to these problems.

5.1 CONCEPT OF CONSERVATION

It is important to understand the concept of conservation to start with the actual process. Concept of conservation has been defined by many Government and Non-Government institutions at national and international levels.

The World Conservation Strategy, launched by International Union for the Conservation of Nature (IUCN) in 1980, has given a definition of conservation. According to it, 'conservation is the management of human use of the biosphere so that it may yield the greatest sustainable benefit to the present generation while maintaining its potential to meet the needs and aspirations of future generations'[1].

'Conservation' is an associated term with sustainable development. The concept of sustainable development was introduced by the Brundtland Commission in 1987. The Commission defined sustainable development as "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs"[2]. The definition presents the needs of coming generations also. If future generations are not to be made worse off by present-day activities, they require the economic opportunities with same potential. It is must for improving their welfare as the current generation enjoys. It is clear that sustainable development should also be the main priority in managing wetlands. Care should be taken to avoid overexploitation of these resources in the development processes.

Thus, conservation does not necessarily imply complete protection against all kinds of human interference. It allows for sustainable utilization or 'wise use' of natural resources. At the global scale, key problems threatening natural resources and the sustainability of life support systems are: (1) soil degradation, (2) scarcity of water and (3) the loss of biodiversity. These occur virtually in all socio-cultural and economic contexts worldwide.

There is increased global emphasis on sustainable use of wetland resources. The Ramsar convention emphasizes the concept of 'wise use' of these resources. According to the convention, wise use of wetlands refers to "their sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem"[3].

It has been estimated that at a tick of every minute of the clock, one hectare of wetland is getting degraded or drained all over the world. The effect on the water bodies has become 'catastrophic' in a number of regions. In Ireland, out of an actual area of 3,11,000 hectares of bogs, only 23,000 hectares remain. In Bulgaria, there were vast wetlands in the past along the bank of Danube. Most of these have been drained after a flood control dyke was built along the bank. Wetlands are suffering from the same condition in Japan, New Zealand, Chile, Norway, U.K. and other countries. Intensification of agricultural activity, drainage and human interference have led to the decrease of wetland habitats. The fact that rings out loud and clear from the discussion is that wetland is an ecosystem in peril.

There is a tendency to associate wetland conservation only with the endangered species of waterfowl. In fact the Ramsar Convention was initially called the 'Convention on the Wetlands of International Importance especially as Waterfowl Habitat'[4]. This has resulted in narrowing of the whole concept of wetland conservation. In such a scenario, the complete discussion on wetland conservation centers around particular rare or endangered species like Siberian Crane, Rosy Pelican or White Stork. The wider ecological aspects are totally lost sight of. Wetland is an ecosystem and any discussion which does not include the ecological aspects of the total system will be like a body with missing soul.

The management, maintenance and conservation of wetlands can only succeed if built on a strong scientific research. Before the management of a wetland with an action plan, several other steps are necessary to lay the foundation. These steps are shown in a flown diagram (Fig. 5.1)-

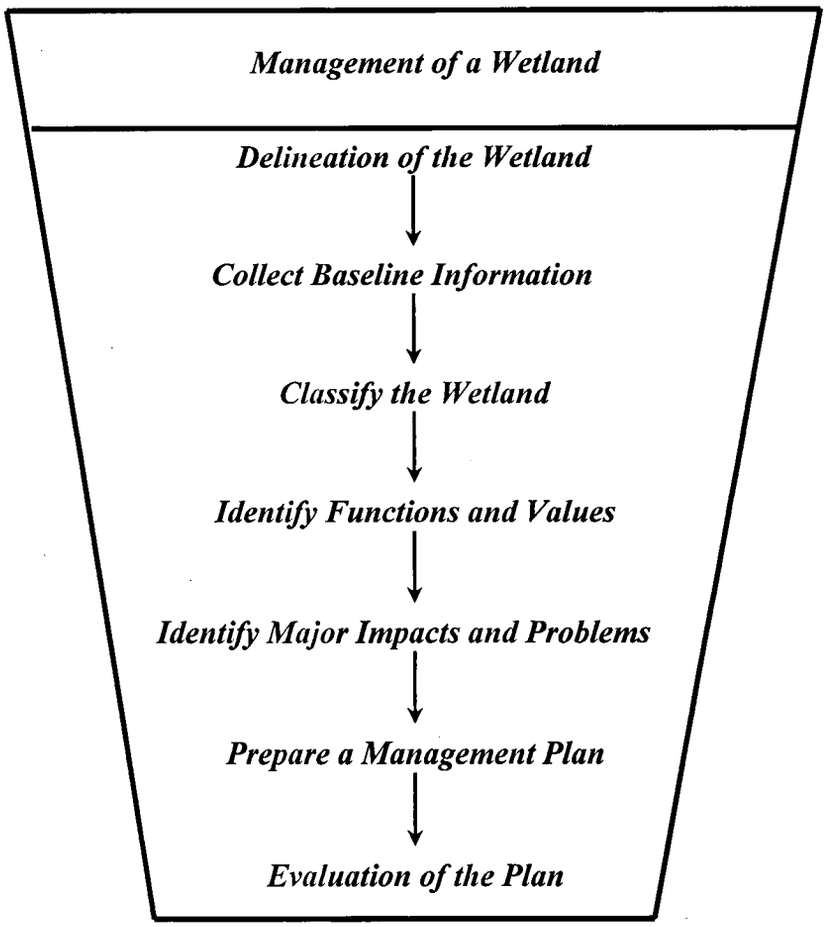

Fig. 5.1 Managerial Steps for Wetland Conservation

Apart from managing the wetlands through these steps some strong strategies are to be implemented on international and national levels. World Conservation Strategy was launched for the same purpose by IUCN, WWF and UNEP in 1980[5]. One of the major goals of the strategy is the integration of conservation and development. It ensures the modifications to the environment secure the survival and well-being of people. The goal of the conservation community is not to stop wetland development, but to ensure that – if undone – it is carried out in a way which minimizes the environmental costs.

The World Conservation Strategy emphasizes on the discussion of the main threats to the existence of all types of wetlands in the world before carrying out a management plan. There are some common threats which are responsible for the deterioration of wetlands all over the world. The main issues which come in these threats are –

- Rise in sea level due to global warming and climatic changes. The coastal wetlands are the most vulnerable in this regard but others also cannot escape. It is resulting into inundation of wetlands.
- Increasing human settlements, urbanization and industrialization near wetland ecosystems.
- Increasing human interference in terms of occupational, social and cultural dependence on wetlands.
- Denudation in the catchment area which results into siltation in wetlands.
- All types of pollutions and eutrophication which are responsible for the degradation of water quality, water fowl and biodiversity.
- Construction of hydro-electricity dam on wetlands.

It is now clear that wetlands are one of the important ecosystems on the earth which are suffering from various deteriorations and need to be properly managed.

5.2 INDIAN SCENARIO

India has a large wealth of wetlands. This wealth is spread according to its vast area, varied terrain, climate and geographical position. These characteristics range from the cold desert of Ladakh to the warm arid desert of Rajasthan, with a coast line of more than 7500 km, with its major river systems and lofty mountain ranges.

The largest wetland regime of India is the Indo-Gangetic flood plain. These remain submerged for a longer time due to copious precipitation. Most of the natural wetlands of India are connected with the river systems of the north and the south. The various multi purpose projects launched to harness these river systems have provided a number of man-made wetlands. These are Harike barrage, Bhakra Nagal dam, Kosi barrage etc. There is also a network of lakes – natural as well as man-made. These are Khabar Taal, Chilka lake, Pichola Complex, Sukhna lake, Keoladeo National Park etc. It is estimated that there are about 4.1 million hectares of wetlands of which 1.5 million are natural and 2.6 million man-made.

Vast areas of wetlands in India have been encroached for agriculture or drained for housing and industrial purposes. The main threats to the wetland ecosystems in India

are drought, cyclones, erosion, deforestation, urban encroachment, overexploitation, weed increase etc. Large scale deforestation in catchment areas results in siltation.

The great Wuller lake in Kashmir has now been reduced to 1/3 of its original size due to siltation and encroachment. Mouth of Chilka lake has become silted to such an extent that there is no access of sea water in the lake. As a result the entire ecosystem is undergoing a change. Another problem is weeds – floating and submerged. The examples are *Salvina, Eichornia, Typha* etc. The worst is *Water Hyacinth* or *Echornia.* About 75 per cent of Harike lake is occupied by this unbearable weed which is of American origin. The sheer mass of this weed and its capacity for multiplication is posing a challenge to conservationists. Construction of dams and bunds affect the water flow and modifies the character of wetlands. The worst is pollution from human habitation, industrial effluents and nutrients. The flow of nutrients into wetlands leads to eutrophication.

5.3 EFFORTS MADE BY GOVERNMENT

Realizing the crucial role of the wetland ecosystem, the Government of India has mounted determined efforts for its conservation in the past decade. First of all, a National Wetland Committee was set up on 24th March, 1987. It consisted of experts from different disciplines for advising the Government on the selection of the sites and drawing up conservation strategies. This Committee selected 10 wetlands to start with, for preparation of management action plan. Later 6 more were added to the list. State Level Committees were also formed to assist the National Committee.

Unless authentic data is available, no concrete plan for conservation is possible. So, the first plank of the effort was surveying and collection of data. These were further updated and for the first time the Government of India brought out a directory of wetlands of India. It was an attempt to put all information collected from diverse places in one place through this directory. The directory provides data on location, geographical coordinates, area and ecological category of wetlands over 100 hectares arranged State-wise and Union Territory-wise. Information has been given separately for natural wetlands and man-made wetlands. All these efforts got converged during the Seventh Plan.

It was fully realized till the time that management strategies for wetlands will be meaningless without backup of research. So, second plank of the effort was to evolve area specific management strategies with strong research bases. This was accomplished by designating one or more research institutions for each of the area for action oriented research. Simultaneously, steps were initiated for mapping of wetlands and a detailed resource survey of each of these areas. The Botanical Survey of India and the Zoological Survey of India have been asked to carry out studies on plants and animals respectively of all selected wetlands.

Management programmes for conservation of wetlands involve fairly sizable investments. For example, de-siltation of Chilka mouth requires Rs. 4 to 5 crore in every five years. Similarly a plan of diversion of the entire city sewage which is going into the lake for last many years is needed to save Pichola Complex. It also requires a big sum of money. Neither the States nor the Central resources are at present adequate for taking up these conservation programmes. There is a positive scene, at present, in the developed nations like Canada, Japan, Norway, Sweden etc. for assisting conservation efforts. The best use of this opportunity should be made for rehabilitating the wetlands in India. As the Canadian International Development Agency (CIDA), Japan Government, the U.S. Fish and Wildlife Service and others have shown their environmental interests in assisting Indian wetland wealth[6]. Chilka lake, Bhoj wetland, Keoladeo National Park, Loktak and Asthaimudi Lakes have been assisted and sponsored by these countries and agencies.

Apart from this, the best way to protect the wetlands is not by legislation but by educating the people living around and dependent on these ecosystems. They should be made aware about the importance of wetlands and also what they stand to lose if these ecosystems perish. Therefore, awareness building programmes should receive top priority. Voluntary organizations should be involved closely in these programmes.

5.4 MANAGEMENT AND CONSERVATION IN KNP

Before discussing the major management issues in Keoladeo National Park, a quarry should be resolved. Should there be a management programme for a national park? There are two views presented by various environmentalists, botanists, zoologists

and researchers. The first group insists that national parks and sanctuaries should be left to themselves and be allowed to exist naturally[7]. The other group is of the opinion to conserve and manage national parks and sanctuaries. National Parks and sanctuaries which are natural and completely free from human influence may not require management. But, in the case of parks and sanctuaries which are man-made and modified, or even influenced indirectly by human beings, intervention of a well-planned management programme is necessary. Keoladeo National Park falls in the latter category. Two vital components of the system, namely water and vegetation have been controlled by man for centuries.

Management of any area should be determined considering its significance for conservation. As mentioned earlier, Keoladeo National Park has been identified as a Ramsar site, a wetland of international importance, especially as waterfowl habitat, and also as a World Heritage Site. This shows that this wetland needs to be conserved and managed. The ecosystem with its functions, values and biodiversity should be preserved and managed taking into account the whole community rather than a few species. Such management requires the knowledge of utilization of the habitats by wildlife and its impact on the system.

A decade long study by the team of Bombay Natural History Society (BNHS) headed by Dr. Salim Ali and V.S. Vijayan was done in Keoladeo National Park. It was especially concerned with the study of wetland ecosystem. Many other botanical, zoological, ecological and social research studies have been carried out in the same area. All the studies have brought out two common management issues – the management of water and vegetation in the Park. As it is an artificial or manmade wetland in a natural depression, there is a necessity for active management of this system.

MAJOR THREATS AND THEIR MANAGEMENT

Major threats to the system are the paucity of water, extensive growth of weed in the Park, siltation, heavy metal and pesticide contamination and human interference. These threats have already been discussed in the previous chapters. The conservation measures of the above are as follows:

5.4.1 Water management

Water, no doubt, is the key factor of any wetland system. The quantity, quality, and time of supply along with the duration of the dry period determine the biological cycles and the functioning of the wetland system. Keoladeo undergoes a cycle of ecological changes with changing seasons. With the arrival of monsoon and the subsequent release of water into the Park through the canal, life enters in various forms. Turtles resume their normal life, seeds germinate, herons, waterfowls and dozens of other waterbirds start nesting (Plate 7). The migratory birds after an arduous trip begin to arrive by mid September. Their numbers reach a peak in December-January and they start their journey back home in February. By March-April, most of the long distance birds depart, leaving the wetland with its gradually receding lakes and canal for the resident birds (Plate 8). In the following months, the wetland dries up, leaving few pools in deep areas. These pools resplendent with surviving fish, attract flocks of a variety of fish eating birds, and are also a refuge to many turtles. With the advancement of summer, the pools disappear creating cracks on the surface of dried wetland. The upland tracts transform into dry grasslands. The resident fauna takes refuge wherever it can, awaiting the inception of the monsoon. The wetland provides an appropriate climate and weather conditions with ample food for the guest and host birds. They lay eggs in their nests, hatch these eggs and when the baby birds come out to fly in a new world, they feed them. Their food is in the form of weeds and uncountable 'fish–fry'. These fish–fry come with the water supplied from Ajan Bund. With this food, birds like to eat insects also which play the role of decomposers in the food and life cycle. A large population of ungulates in the park like nilgai, sambar, spotted deer (cheetal), blackbucks, wild boars and feral cattle also forms a part of this cycle. And to complete this cycle carnivores like hyaena, jackal, jungle cat, fishing cat, common mongoose, toddy cat and otter are the permanent dwellers of the park. These all simulate and integrate a life cycle naturally in the Park.

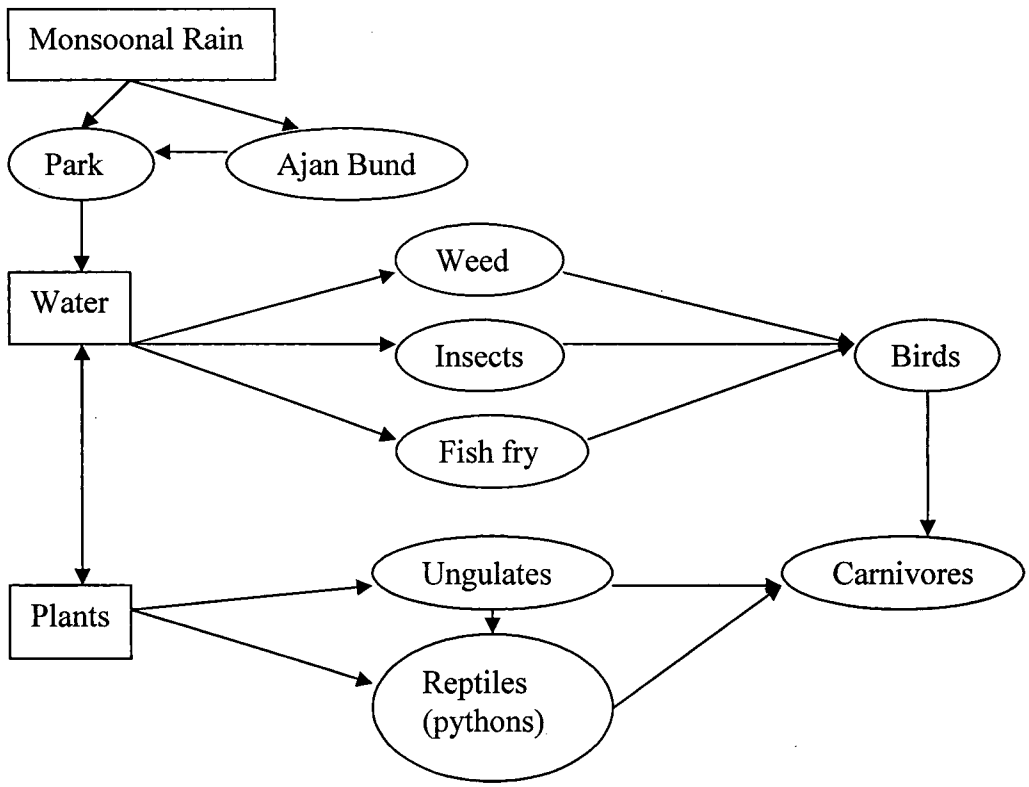

Fig.5.2: Productivity Cycle in Keoladeo National Park

The same cycle has been observed in the case of many wetlands and marshes[8]. The optimum amount of water required for Keoladeo is recommended at 600 million cubic feet. It should be released between the first and third weeks of July. But, the time of release of water to the Park mostly does not match the right time. At the same time it has not supplied as per the required amount for at least last thirty years (Plate 9). Apart from this, this area has a history of floods and droughts; the frequency of these has changed over the decades during this century. There has been a decrease in floods and increase in droughts since 1980[9]. This has become a major concern because of reduction in the water supply from rivers due to increased human use. Although priorities have been spelt out in providing adequate quantities of water to the Park in time, increased human demand can not be over ridden. Hence, the greater concern should be in locating feasible alternative sources.

5.4.1.1 Alternative Sources of Water

As the supply of water from the Banganga river has almost stopped in recent years and that from the Gambhir river has become increasingly difficult. Supply from the Gambhir river has been halted by the people of Karauli district who are being benefited by Panchana dam on the river. Therefore, alternate sources have to be found out. The only two options are –

1) use of ground water, and
2) bringing in water from another river.

As it has been discussed earlier that groundwater is inadvisable and also not feasible. It has been shown that the use of ground water which is saline will change the plant community of the wetland. It will also not support the incoming of fish-fry from the canal which is the main food of waterfowl and Herons in the wetland. So it will not be vital for the maintenance of the ecology of the Park. Therefore, groundwater will not be an effective alternative.

The next option is to bring water either from the Yamuna or the Chambal river. The Yamuna river is highly polluted with industrial effluents, so it is not a healthy alternative for the conservation of the wetland. The only option remains with the Chambal river. It is understood that the cost of bringing water from the Chambal river would be high. So, the cost may be justifiable only when the water brought in could also be used for irrigation thereby improving the economy of rural population in the area. Apart from this, the water carried from the river should be used only in the years of scarcity so that it could be used regularly for agricultural practices. But the quantity of water taken should be in accordance to the water regime in the Chambal and be taken when there is not enough supply from Panchana reservoir. It must not affect the requirements of the other people dependent on the Chambal, so that another conflict does not take shape.

5.4.1.2 The Time of Release of Water

The time of release of water to the park should be regularized between the first and third weeks of July. It should be done in a single stretch otherwise the nests of

residents birds would be washed out. With proper time, volume of water should also be fixed between 550 to 600 mcft.

5.4.1.3 Water Depth in each Block

Water depth in each block should be kept at different levels so that habitat diversity would be available providing the specific depth requirement of each species of birds. It will stop the bird species to invade the blocks specified for some endangered birds. It will also delineate the particular and safe places for the bird species to breed and nest. Apart form this, the supply should follow a sequence in filling the various blocks. It has also been recommended that initially the water level should be kept between 20 and 25 cm and after filling all the blocks the level should be raised to about 120 cm[10].

5.4.1.4 Deepening of the Water spread Area

Selected portions (D, E, and L blocks) of the water spread area should be deepened for diversifying the habitat and limiting the growth of weeds. It will also help to maintain the preferred habitat of endangered Siberian crane which digs out its food in the form of sedges and tubers from deep waters.

A Central Empowered Committee (CEC) was formed by the Supreme Court after the public petitions were filed in 2004[11]. The committee looked into the whole matter. It was satisfied by the recommendations and execution of Rajasthan Government. The State Government has introduced Chambal-Dholpur-Bharatpur Project (CDBP) for drinking water supply to 999 villages of Dholpur and Bharatpur districts. Keoladeo National Park will also be supplied water from this project. This water will be supplied through a pipeline and will be chemically treated clean water. Environmentalists, hydrologists and biologists claim that this chemically treated drinking water will be free from fish-fry and small organisms. These are the main food of waterfowl migrating to the wetland.

An alternate can be brought about by carrying water through a narrow canal separately parallel to the proposed pipeline. The villagers living around the Park should be involved in digging this narrow canal. Thus, the water brought will contain fish-fry with organic bodies. This method will also be cost effective.

5.4.2 Vegetation Management

Vegetation is another important aspect of management in Keoladeo wetland. The emergent vegetation, which is not less productive than Tropical forests[12], had been controlled by the buffaloes of the villages ever since the origin of the wetland. Since this area was declared a National Park, it was decided to ban grazing by buffaloes inside the Park. Feral cattle which are abundant inside the Park, do not usually feed inside the flooded wetland. Sambar also feed in the wetland during winter but do not help in checking the aquatic grass since there number is negligible. Hence, the biomass of the emergent vegetation reaches a maximum of about one kilogram per square meter in a year. The entire wetland chokes with grass, particularly *Paspalum Distichum*, diminishing the open water expanses, which is preferred habitat of many waterfowl[13].

All the possible management techniques such as clearing the areas by cutting, scrapping, bulldozing or burning have been experimented to find ways to check the uncontrolled growth of grasses inside the wetland. But the methods are not found suitable as these help only for short periods. Apart form this, bulldozing and burning had various other disastrous impacts on the system.

The importance of traditional management practices have not been taken seriously while deciding management strategies for many wetlands. The significance of traditional grazing practices in the Park has already come in front of environmentalists, conservationists, park administration and Government. After the pressure laid by environmentalists and conservationists, the Park administration allowed grazing inside the Park but for very limited period in extreme summers. This time should be increased and extended to the months when the grass is on extreme. This conservation measure will profit villagers, Park administration and thus the whole ecosystem of the Park.

5.4.3 Siltation Management

As it has been described earlier, siltation is one of the main threats responsible for the degradation of wetlands all over the world. A large quantity of silt comes to the park with the water supplied from Ajan bund. The depth of lakes in the park was more than 4.5 feet earlier. But after 1988, the removal of siltation has not been done in the wetland.

It has resulted into the decrease of water depth from 4.5 feet to 3 feet. It has also devoured some preferred habitats of a few of migratory birds.

In respect of some managerial strategies, sluice gates of the blocks which adjoin all the blocks should be renewed (Plate 10). A small check wall of low height should be constructed at the entrance of the canal to the Park to check the silt coming with the flow of water. Apart from this, a natural measure will be much appropriate to stop more silt to enter the wetland. The catchment area of 'Ajan bund' comes under cultivation land and therefore, is left less vegetated. Only a few scattered patches of trees can be seen in the area. Taking one more step towards the conservation of the Park, vegetation must be increased in the catchment area of Ajan bund. Trees of economic values should be planted which will be a profitable idea for the villagers living around the Park.

5.4.4 Management of Feral Cattle and Monkeys

In the absence of the buffaloes after the ban applied on the grazing inside the Park since 1982, the feral cattle appear to be assuming their role. Their population has been increasing for the last two decades (Plate 11). It is also to be noted that the feral cattle do not prefer to graze in the aquatic areas and hence, do not help in checking in the spread of weed like *Paspalum distichum*. These feral cattle are left in the Park by the villagers by opening the boundary wall or lifting these cattle physically.

The Park administration has many times tried to catch these animals and transport them to either a '*Gaoshala*' or Chambal ravines. The activity has been prescribed under the management plan from year 1997 till July 2005. But, still there are about 1100 feral cows inside the Park[14]. A solution for this problem may be increasing the height of boundary wall and mending the opened gaps in the wall. More forest guards can be deployed at boundary wall to check these activities of the villagers.

Increasing population of monkeys in last five years is also a critical problem inside the Park. Monkeys destroy the nests and eggs of the breeding birds. It is leading to decrease in the population of herons and waterfowl. Apart from that, they have created troubles for the visitors by snatching away their valuables. The Park administration has given contract to the monkey catchers from Mathura. Professional monkey-catchers are available in Mathura only and are widely employed for catching monkeys in north India.

The monkeys caught have been transported in the department vehicles and released in the Chambal ravines under the supervision of the Park staff. Many times during these practices, organizations like PETA have raised objection. For the conservation of the Park, these animal welfare organisations should be made aware about the fragility of such ecosystems where an unwanted link can lead whole system towards destruction.

5.4.5 Social and Cultural Management

It has been stated earlier that Keoladeo wetland is well associated with the people living in the villages around it. It has affected their culture, traditions, economy, occupation, agricultural patterns and other things since its formation in 18th centaury. It has been quoted in many studies that wetlands can not be properly managed without involving the people who are directly and indirectly related to these fragile ecosystems. Even the Ramsar convention also has asked its signatory parties to make a better involvement of society to draw and implement a management plan.

As far as Keoladeo National Park is concerned, it has been affected by two groups of populations – the people living near to it and the people living far from it. The latter group is involved in diverting the Gambhir river which is the main water source of the Park. In this concern, first of all an earthen dam, namely ***Panchana*** was built in 1992. The height of the dam was regularly raised in later years something in more problems for the Park. Adding more to the conflict, now these people want to stop the water to the Park for ever without thinking about the importance of this aquatic body in a semi-arid area. The State Government earlier tried to lay pressure on this community. But, surprisingly later it favoured these people leaving the Park waterless. The Government has discussed about the costly alternative of bringing water from Chambal river. The estimated cost of this project is Rs. 100 crore. Water will be carried through a pipeline directly from the Chambal river. Despite this costly project, the Government can think over the plan to connect the Gambhir river with the Chambal river directly. It will be less in cost and will benefit the people in Karauli district also.

The first group is busy in degrading the Park by fetching direct benefits such as – leaving their feral and unproductive cattle in the Park, stealing firewood from the Park,

collecting honey, fiber, gum and fishing while these activities are banned inside the Park. Apart from this, they have diverted the Ghana canal many times for irrigating their fields.

All these problems are to be managed through a proper channel in which the locals will also participate by understanding their own importance in the conservation of the Park. The Government has run some awareness programmes in the surrounding villages to describe the importance of the Park for the existence of these villages. The Government has planted some bio-gas plants for the poor villagers in last five years. It will reduce the dependence of the villagers on the Park for fuel wood. The Government has arranged reservations and priorities for the surrounding villagers in the jobs in the Park. But this all is a drop in the ocean. Some villagers are still carrying out activities resulting in the degradation this ecosystem. There are 25 forest guards for the safety of the Park, the number should be increased by the Park administration to provide more safety on the boundary.

An Integrated Development Programme has been recommended by Vijayan in 1991 for the proper management and sustainable development of the Park[15]. The IDP proposes various schemes for solar cookers, economy chulhas, wind mills, cottage industries, afforestation, improving agricultural practices, proper fodder supply, education and other social upliftment programmes. If the scheme is implemented, it will boost the economy of the rural people in the area. But the Government is yet to implement these in full mode. By improving the living standards of the people around the Park, it envisages the full cooperation of villagers in the conservation and sustainable development of the Park.

Wetlands have been vulnerable ecosystems those need to be conserved to maintain their values and potentials. In this particular way, a lot of steps have been taken by the Government on general basis. Since every wetland is different from the other in terms of physical setup and biological attributes, thus they need to be treated specifically. Identification of problems and thereby finding the solution has to be the process. In this regard, the problems identified in case of Keoladeo include paucity of water, extensive growth of weed in the Park, siltation, heavy metal and pesticide contamination and human interference. To mitigate the water paucity, since groundwater is not feasible, it

has been proposed that waters of Chambal and Gambhir should be interlinked so that it also benefits the people of Karauli along with Keoladeo. In case of siltation, a check wall can be constructed to restrain the silt from entering the wetland. For weed management, the ban on grazing should be lifted at least when the weed growth is at peak. Similarly other problems also need to be addressed to before these create havoc for the Park. This is the only way out to preserve this dilapidating wetland.

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Chapter 6

SUMMARY & CONCLUSION

'Wetlands are areas of marshes, fen, peatland, permanent or temporary, with water that is static or flowing, fresh, brackish or salty, including areas of marine water, the depth of which at low tide does not exceed six meters'. This definition of wetland was evolved in 'RAMSAR CONVENTION' (1971) by International Union for the Conservation of Nature (IUCN).

Thus, a general definition for wetlands could be set that wetlands are basically water logged lands where the soil is saturated with water at least sometime during a year. A lot of land is water logged during rainy season but it does not mean that all this land is 'wetland'. Wetlands are mostly characterized by specific plants and animals, which are particularly adapted to water logging of soils during their growth period.

Wetlands exhibit very large variety in their habitat characteristics. Wetlands also occur in all sizes and shapes ranging from less than one hectare to hundreds of square kilometers in area. In very general terms, wetlands are distinguished by latitudes – temperate and tropical.

Wetlands have become an integral part of the environment since earliest times, and sometime of the economy as well. A wetland can originate due to various factors like periodic overflowing of rivers in flood plains, rise and fall of tides along the coast, impeded surface flow due to tilting and unusual climatic events. Apart from these, deposition of sediments in deltas, rising of water table above the surface level and occasional tidal inundation caused by land subsidence are also reasons for the formation of wetlands.

Wetlands are probably one of the earth's most important fresh water resources and similarly threatened also. These play an important and active role in taking care of nature's balance. These are estimated to cover about 6 per cent of the land's surface. Wetlands perform manifold functions in the maintenance of ecological balance of the region. These are divided into three broad heads – hydrological, biological and biogeochemical functions. Wetlands provide people – directly and indirectly – an enormous range of goods and services. These are in the form of staple food plants, fertile grazing land, support for coastal and inland fisheries, flood control, breeding grounds for waterfowl, fiber and fuel, among others. Despite of providing economic profits to humans, wetlands contribute in the moderation of the climate of surrounding areas.

Wetlands are among the least protected ecosystems in developing countries, and India is particularly vulnerable to their degradation and loss. India has unique geographical position with varied terrain and climate. India contains a wealth of wetlands. Wetlands in India have been neglected. Most of the natural wetlands of India are connected with the river systems. The various multi purpose projects launched to harness these river systems have also provided a number of man-made wetlands. It has been estimated that an area covering about 4.1 million hectares is under wetlands in India. Despite their niche status and vital economic role, State Governments classify wetlands only as wastelands in land records. India's environmental policy is sadly poised to repeat the mistakes of the developed world.

The threats to the wetland ecosystem in India can be classified under two broad heads – 'Natural and Human'. The natural threats are subsidence, cyclones, siltation and shifting of river mouth etc. Human threats come from over exploitation, encroachment, reclamation for agricultural and other purposes. The worst is pollution from human habitation, the industrial effluents and nutrient load leading to weed growth. Apart from these, insufficient funding and ineffective legal protection are also prevalent.

Keoladeo National Park (KNP) is a good example of a wetland as it has rich bio-diversity. It lies in Bharatpur district on the eastern most side of Rajasthan. It is a remnant of an oxbow lake of river Yamuna which later shifted its course to Mathura district. It was developed as duck shooting reserve by the rulers of princely state of Bharatpur for their entertainment. It was declared a bird sanctuary in 1956 as a step to conserve it. It was later upgraded to a National Park in 1981. KNP has been designated as Ramsar Site and also declared a 'World Heritage' by UNESCO. It lies in a semi-arid region. Additional water is supplied to it through a canal which originates from 'Ajan bund'. This supply has continuously decreased in the past 30 years reaching 18 mcft in 2004-05 as against the requirement of 600 mcft water. The study of physical and chemical characteristics of the wetland shows degradation in the water quality of the area.

The wetland is a habitat for about 370 bird species, 27 species of fauna and 43 fish species and a variety of other wild life and plant species. Important species of flora include *Acacia Nilotica*, *Prosopis Juliflora*, *Mitragyana Parvifolia*, *Zyzyphus*, *Vetiveria Zizanioides* and *Paspalum Distichum* etc. Important faunal species found there are

Siberian and Sarus cranes, Painted storks, Grayleg geese, Herons, Great Indian Egret, Nilgai, Cheetal, Jackals, Pythons, Jungle cat etc. This wetland provides the only nesting place to migratory birds coming from Siberia, Sberian Cranes being the most important one.

Keoladeo wetland holds some unmatched values like playing a vital role in environmental functioning, a unique refuge for some endangered bird species, providing food, fuel and fodder, tourism, providing employment to surrounding population etc. The population in the surrounding of the wetland has exploited it at an alarming rate. This has created a number of problems that have threatened its existence. These include environmental contamination, siltation, insufficiency of water, etc. Brutality of climate is another factor which is carving its impression on this wetland. Rainfall has been varied in the region showing a decreasing trend, thereby giving rise to water deficiency. Winter temperature in the area has showed an increasing trend increasing the evapo-transpiration. The cumulative effect of these has led to some distressing consequences. The water spread area of the wetland has started to decline and will continue to do so if strict measures are not taken immediately. An outlying small wetland area has already diminished. Siberian cranes, which are among the most important visitors of the Park, are no more visiting the Park in due numbers. In fact in the past few years, not even a single Siberian crane has visited the Park. This truly indicates towards the deteriorating condition of the park.

Social dependence is the most probable cause for deterioration of Keoladeo wetland. The villages surrounding the Park have been very much dependent on it for their basic needs since early times. They exploit the Park for their requirement without even having consideration for it. They usually graze their cattle inside the Park. Whenever required, they even divert the canals and take water for irrigation or domestic purposes. They also collect various things from there like fuel wood, honey and grass etc. Such illegal activities have created forest fire inside the Park many a times. Apart from this, the Park has also been a very important source of employment for the villagers.

Though this valuable wetland is so much significant in the lives of the villagers still it is facing many controversies. Since it is a rainfed wetland, it is usually subject to water crisis. Thus, the major controversy is regarding the supply of water. Supply of

water from Panchana dam reservoir to 'Ajan bund' is also problematic. The people in its catchment strictly disagree to provide water to Keoladeo due to their own interests. The State Government and other politicians have also been biased in the matter. And it has not been resolved till now. Other proposals that are on cards have not been materialized yet. Of all the controversies, the irresponsible and careless attitude of the locals for the management of the Park is the major one. They have been exploiting the resources too recklessly without being least bothered about conserving these. This all together has led to immense degradation of the Park.

Wetlands have been vulnerable ecosystems that need to be conserved to maintain their values and potentials. In this particular way, a lot of steps have been taken by the Government on general basis. Since every wetland is different from the other in terms of physical setup and biological attributes, thus these need to be treated specifically.

The manner in which degradation of this wetland is taking place, there is a risk that this site might lose its status of 'World Heritage'. So there is an urgent need to look into the matter. This is really important that the values of the Park are utilized to an optimum level and that too sustainably. This will not only maintain the ecosystem of the Park but also make these values available to the coming generations. In this regard, the problems identified in the case of Keoladeo include paucity of water, extensive growth of weed in the Park, siltation, heavy metal and pesticide contamination and human interference. Since groundwater is not viable being saline and uneconomic, it has been proposed that the water paucity can be combated by linking the waters of the Chambal and the Gambhir rivers. It will also benefit the people of Karauli district along with Keoladeo. Another alternative to this can be construction of a canal bringing water direct from the Chambal river. Siltation can be restrained by constructing a check wall of low height to hold back the silt from entering the wetland. It will stop only the sediments and not the water. For weed management, the ban on grazing should be lifted at least when the weed growth is at peak. Similarly other problems also need to be tackled before these create havoc for the Park. This is the only way out to preserve this dilapidating wetland.

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(Courtesy: Salim Ali Interpretation Center, KNP)

Plate 1. Shooting party headed by Lord Linlithgow, on 12th November, 1938 killing 4,273 birds in KNP

(Courtesy: Salim Ali Interpretation Center, KNP)

Plate 2. Historical Inscriptions on pillars near Keoladeo Temple in KNP.

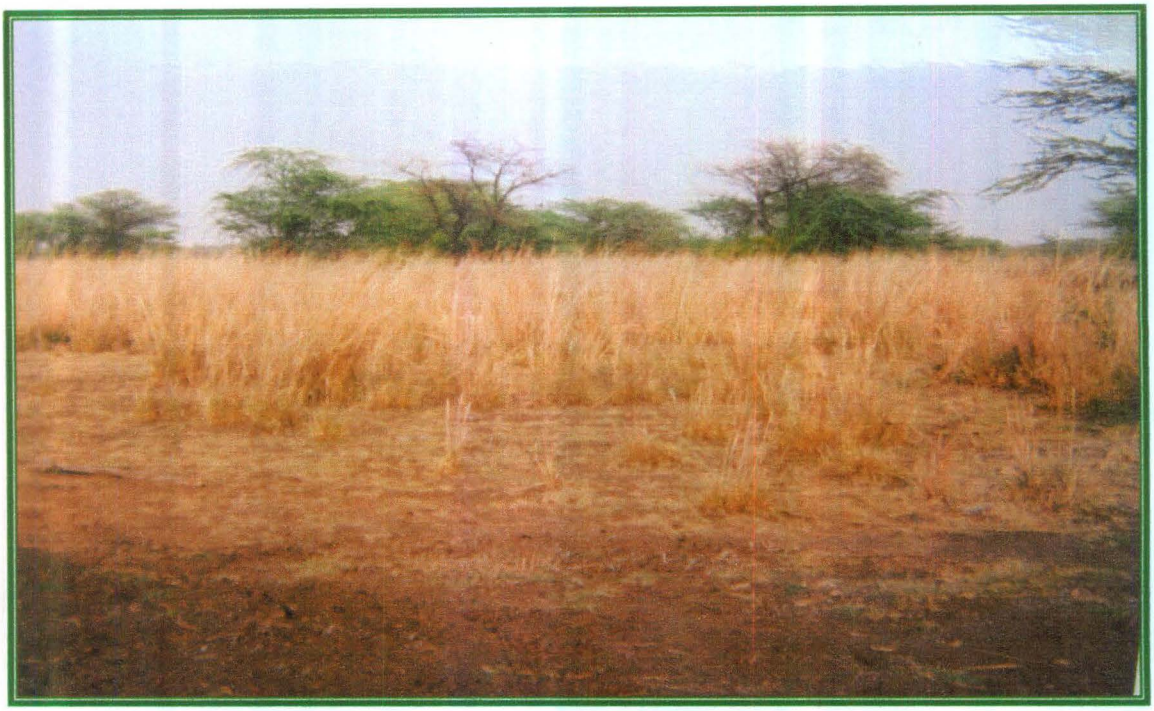

Plate 3. *Khus Grass* in drylands of Keoladeo National Park in summers.

(Courtesy: Salim Ali Interpretation Center, KNP)

Plate 4. A panoramic view of the 'bird paradise' (KNP) in winters.

Plate 5. Cultivation done in the catchment of 'Ajan bund'.

(Courtesy: Salim Ali Interpretation Center, KNP)

Plate 6. A pair of 'Snow-Wreaths' (Siberian Cranes) in Keoladeo National Park.

(Courtesy: Salim Ali Interpretation Center, KNP)

Plate 7. Migratory birds nesting in Keoladeo Wetland in winters.

Plate 8. Receding *Dakan Mori* canal in summers in Keoladeo National Park.

Plate 9. Empty 'Ajan bund' reservoir in summers.

Plate 10. A Sluice gate between two blocks of Keoladeo National Park.

Plate 11. Feral cattle grazing inside Keoladeo National Park.