

biodiversity

STRATEGY & ACTION PLAN

CHANDIGARH, U.T.

Prepared by :

Department of Environment,
Chandigarh Administration

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(Ishwar Singh)

Dy. Conservator of Forests cum Director, Environment,
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Preface

Throughout the world, increasing interest is being expressed in environmental issues, largely as a result of the serious concern that is felt about the present state of both the local and global environment and the predictions that have been made about the future trends. This awareness is based on a realization that the state of the Earth's biological systems is of fundamental importance for human society and that our influence on these systems is increasing exponentially. During the last decade, much of this interest and concern has focused on the issue of biodiversity.

The term biodiversity - the presence of a large number of species of animals and plants - is now generally recognised as being important by many people. There has been increasing concern over declining biodiversity due to over exploitation, habitat destruction by humans, introduction of exotics and monoculture, massive impact of economic activity, rapid urbanisation, enormous increase in pollution specially vehicular pollution, loss of sources of knowledge, unsustainable models of development, alienation of people from natural resources, inappropriate or contradictory policies and laws, over centralisation of decision making, lack of administrative coordination etc. Somebody aptly remarked that, "*Biodiversity, the planet's most valuable resource, is on loan to us from our children*". It will be a major challenge to avoid a staggering loss of biodiversity in the decades and centuries ahead.

Some scientists and policy makers are worried that the magnitude of the biodiversity we know to be present in the world's habitat is so enormous, the cost of exploring and documenting it so overwhelming, and the number of biologists who can analyse and document is so small that the goal of understanding the diversity of the world's species is

unattainable. But there can be cost effective and feasible ways of approaching the conservation of biological resources. Rather than building of knowledge, institutional, and physical infrastructure for documenting biodiversity from the ground up, we need to build upon the preexisting infrastructure and increase the collaboration of research institutions, universities and museums; the pooling of human and financial resources; the shared use of physical and institutional structures that are already present.

INTRODUCTION

1.1 INTRODUCTION :

Biodiversity represents the very foundation of human existence. Yet by our heedless actions we are eroding this biological capital at an alarming rate. Even today, despite the destruction that we have inflicted on the environment and its natural bounty, its resilience is taken for granted. But the more we learn of the workings of the natural world, the clearer it becomes that there is a limit to the disruption that the environment can endure. Biodiversity as a part of our daily lives and livelihoods, constitutes the resources upon which families, communities, nations and future generations depend.

With the aforesaid in view, the Ministry of Environment and Forests, Government of India started a process for making of National Biodiversity Strategy and Action Plan. As there is a need to prepare detailed action plans at state, regional, and sub-state levels to conserve and sustainable use biodiversity, to protect the cultural, scientific, spiritual traditions and innovations related to it, and to equitably share the benefits arising from sustainable use. In Union Territory of Chandigarh, Department of Environment, Chandigarh Administration is coordinating the programme and had entrusted the task to YUVSATTA- an NGO..

1.2 SCOPE OF THE STRATEGY AND ACTION PLAN :

The present document is an action plan for conservation of biodiversity in Union Territory of Chandigarh prepared/compiled by Yuvsatta for Department of Environment, Chandigarh Administration.

Chandigarh is basically an urban area. Urban biodiversity-what a misnomer, one might think. Not quite, a closer look reveals. Indian cities host phenomenal levels of biodiversity. Zoological Survey of India published five years ago a professional compilation of checklists of various animal groups around Delhi. Naturalists from Bangalore published similar checklists in a popular fashion with the help of WWF-India. Ecological Society in collaboration with RANWA has published this year an assessment of species diversity in various impact zones of Pune city. These efforts mirror the state of our urban environment and our concern for the same.

There is no denying the fact that the urban areas are expanding at an enormous rate and in the process the first casualty is biodiversity of the region. Chandigarh's case can't be different. Human habitations are encroaching upon the farmlands, orchards, grasslands, scrub and forests. The traffic on all the city roads, particularly those connecting with adjoining States of Punjab and Haryana is heavy and continuous throughout the day. The city hosts more than half a million vehicles, over three-fourths being two-wheelers and around 200 vehicles on an average are daily added in this list, so the resultant pollution and its effect on biodiversity is another major cause of serious concern.

1.3 OBJECTIVE OF THE STRATEGY AND ACTION PLAN (SAP)

An understanding of eco-restoration process, specially in urban areas, can help its manipulation and replication in neighbouring areas and even other cities. Besides, such ongoing monitoring can easily detect notable declines in certain species like the sparrows and vultures, being noticed and debated currently. If such sudden fluctuations are any signal of impending calamity, the purpose of monitoring is served much beyond academic interest.

By ensuring participation of people from a cross section of society in the biodiversity action plan, it was tried to develop the action-programme from the people's end and not from scientific or bureaucratic point of view.

This report assesses the current state of knowledge, identifies gap in knowledge and critical issues of immediate concern, and draws attention to the steps and strategies for formulating a Biodiversity action plan for Chandigarh.

1.4 CONTENTS OF THE STRATEGY AND ACTION PLAN (SAP) :

In Chandigarh other than the urban area, four other major areas of importance with regard to biodiversity are Micobial (Bacterial & Fungal) biodiversity, Agricultural biodiversity, Lake eco-system and the area falling under Sukhna Wildlife Sanctuary in the Shivalik hills. The SAP is based on and divided into the aforesaid five major areas of concern that were raised in several public meetings organised by the Department of Environment, Chandigarh Administration i.e.

- 1.Preservation of Urban biodiversity
- 2.Micobial (Bacterial & Fungal) biodiversity.
- 3.Agricultural biodiversity of Chandigarh
- 4.Preservation and Promotion of biodiversity of Lake eco-system.
- 5.Preservation and Promotion of biodiversity in the Sukhna Wildlife Sanctuary.

1.5 METHODOLOGY USED IN PREPARATION OF SAP

For preparing a Bio-diversity Action Plan for Chandigarh, the Environment Department of Chandigarh Administration formed a steering committee of nine members with people from different sections. Further four different Thematic Groups on Lake Eco-System, Sukhna Wildlife Sanctuary and Urban bio-diversity a fourth People Participation Thematic Group was formed to involve a greater number of people from a cross section of society in formulation of the draft proposal, and to help in preparing an action plan plus disseminate the messages of preservation and propagation of bio-diversity heritage of the city. While preparing the SAP following methodologies were also followed:

- 1.Consultative meetings with experts already working in the field.
- 2.Senior officers who are directly involved as implementing authorities/agencies of Chandigarh Administration, like from Deptt. of Horticulture, Municipal Corporation etc. are sensitised on the issue and their participation was also ensured.
- 3.Two Public Meetings were organised in the Chandigarh city.
- 4.One Public hearing was organised at a local village Khuda Ali Sher. Reports of Public Hearing is attached as Annexure 1

Besides the aforesaid, literature available at libraries and through personal communication with experts in Panjab University, Chandigarh - specially in A.C. Joshi Library, Deptts. Of Botany, Zoology, Microbiology, Geography etc. was reviewed. This included books, reports, journals & published papers Information was also culled out from Ph.D, M.Phil & M.Sc Thesis.

1.6 KEY PARTICIPANTS :

For preparation of Biodiversity Action and Strategy Plan for Union Territory of Chandigarh, the Department of Environment formed a eleven member steering committee and four different thematic groups on Urban Biodiversity, Lake Eco-System, Sukhna Wildlife Sanctuary and People Participation Thematic Group. A detailed list of the members of Steering Committee and Thematic Groups is attached as Annexure-II.

PROFILE OF THE AREA

2.1 HISTORICAL BACKGROUND :

Prior to the construction of Chandigarh, the present site was a typical rural tract, with a rainfed subsistence agricultural economy. It was dotted with 24 village settlements, surrounded by cultivated land parcelled into consolidated irregular, small fields.

Each settlement had a number of mango groves remnants of which are still visible in parts of the city. There were banyan or pipal trees within the settlements or near village ponds. The majority of houses were kutcha or partially pucca.

Among the physical features, the choes, with their broad, shallow, and dry sandy beds, constituted an important element of landscape. these represented undulations in an otherwise level topography. Hills and mountains provided a panoramic background.

2.2 GENESIS OF THE CITY :

India attained Independence in 1947; but in the process the territory of British India was partitioned to form India and Pakistan. The large and prosperous Province of Punjab, was divided and Lahore, its capital, fell within the borders of Pakistan, leaving Indian Punjab without a capital. The loss of Lahore, a city much loved by its inhabitants, was keenly felt by those who had been compelled to migrate to India. In March, 1948, the Government of Punjab in consultation with the Government of India, approved a 114.59 sq. km tract of land at the foot of the Shivalik Hills in Ropar district as the site of the new capital. An existing village gave its name (Chandi - Goddess of Power + garh - fortress) to the new city.

The decision to build a new city seemed like an extravagant decision to some at the time, but there were practical justifications. After partition, the population of all the existing towns in East Punjab had more than doubled on account of the migration of displaced persons from Pakistan. As a government publication pointed out: “Most of these towns, even before partition, lacked essential amenities such as adequate drainage and water supply and none of them had schools or hospitals which could meet the normal needs of the population according to modern standards for such services.” The new city was needed not only to serve as a capital but also to resettle thousands of refugees who had been uprooted from West Punjab. India’s first Prime Minister, Jawaharlal Nehru enthusiastically supported the project and took sustained interest in its execution. When he visited the project on April 2, 1952, he declared: “Let this be a new town symbolic of the freedom of India, unfettered by the traditions of the past, an expression of the nation’s faith in the future....The new capital of Punjab will be christened as Chandigarh—a name symbolic of the valiant spirit of the Punjabis. Chandigarh is rightly associated with the name of Goddess Chandi — Shakti, or power.”

Although indigenous planners were associated in the planning of the city, the directing persons were foreign experts, led by the world renowned architect and town planner, Le Corbusier.

2.3 SOCIO-ECONOMIC PROFILE OF RESIDENTS :

Chandigarh had to be a city of migrants as it was built on the land acquired and cleared of existing settlements. One of its objectives was to rehabilitate persons displaced from Pakistan in 1947. Early settlers in the city were government officials transferred from Shimla, the temporary capital of Punjab after partition and displaced persons from Pakistan in search of a new home.

According to 1991 census data, around two-third of the city’s population were migrants, the remaining one-third were locally born. About one-third of the migrants hail from Punjab, Uttar Pradesh comes next, having contributed one-fifth of them. Haryana, Himachal Pradesh and Delhi are other important contributors of migrants. The city has attracted migrants from distant states, such as Bihar, Tamil Nadu, West Bengal and Maharashtra. The number of migrants from Nepal is also considerable.

Over one-half of migrants to Chandigarh came from other urban places; the rest had a rural base. An urban origin was more typical of migrants from nearby states, such as Punjab, Haryana, Delhi, and

Jammu and Kashmir. Migrants from relatively distant states, such as Uttar Pradesh, Bihar, and Tamil Nadu, mostly had a rural origin.

By 1991, the Pakistan-born displaced persons had got reduced to about 4% of all in-migrants. In the early sixties, they accounted for nearly 40% of the total population.

2.3.1 POPULATION GROWTH IN THE CITY :

Chandigarh was planned for a finite population of half-a-million : 1,50,000 in Phase I, the 8919 acres of land required for the purpose were acquired by the city administration to start construction. Land for seventeen additional sectors was to be acquired and developed during the second phase to cater for a population of 350,000 in Phase II sectors. Contrary to earlier beliefs, Chandigarh has developed into a rapidly growing city. Between 1961 and 1971, its population increased from 89000 to 219,000 placing it among 142 class 1 cities (population exceeding 100,000) in India. During this decade the growth of its population was 144.9 percent, one of the highest for urban areas in India. According to 1981 census, the population grew by another 70.06 percent to a population of 371,992 during the 1971-81 decade, continuing to maintain the highest rate of growth among the cities in the country. It further increased by around 42.16 percent in 1991 to a total of 6,42,015, though the official figures of 2001 census are still to be announced but unofficial estimates are that Union Territory of Chandigarh has crossed the nine-lakh mark and, going by projections, it will soon enter the one million plus category almost double for which it was originally built. In 1991 population density was 5632 per square kilometre; now its 7903 per square kilometre.

2.4 GEOGRAPHICAL PROFILE OF CHANDIGARH:

The geographical area of the U.T. Chandigarh is 114 sq. km. and another 25.42 sq. km. of the hilly area which has now been declared as 'Sukhna Wildlife Sanctuary' was acquired for soil conservation works. Chandigarh lies at 30° 44'N latitude, 76° 53'E longitude and 280 feet above sea level, with an average altitude of 362m (m.s.l.). The location of Chandigarh is unique as it lies in the foot hill region and is also adjacent to the plains of north India. As such it contains the vegetation of the foot hills and the north Indian plains.

In Chandigarh region, earthquakes of slight to moderate intensity have sometime been experienced. Significant tectonic feature of the region is such that towards its north lies the great Himalyan Boundary Fault.

2.4.1 CLIMATE :

The climatic data of Chandigarh region is characterised by extreme seasonal temperature, long dry, short wet seasons and potential evaporation exceeding precipitation. Hence the climate is characterised by overall dryness except for short spells of rains during markedly long duration of summer and winter.

-Seasons :

Four seasons are noticeable as (i) the rainy season (late-June to mid-September); (ii) the post monsoon or transition season (mid September to mid-November); (iii) the winter of cold season (mid November to mid-March) and (iv) summer or hot season (mid-March to Mid-June). For general vegetation there is major growth period from February-March to November. Leaf fall for non evergreen vegetation is experienced in autumn period during October-November.

-Rainfall :

Southwest monsoons commence in late June and usually continue upto mid-September when there are high intensity showers and the weather is hot and humid. During rainy season the winds from southwest bring recurrent rainfall amounting to nearly 79 % of annual rainfall in the region. Remaining about 21 % is received in cold season from northwest cyclonic winds marked by hailstones or sleet. The variation in annual rainfall on year to year basis is appreciable i.e. 700-1200 mm and the 20 year average for Chandigarh is 1100.7 mm. Dry spell of summer is long but occasional drizzle or thunder storm brings some temporary relief.

- Temperature and Humidity :

May and June are the hottest months of the year with mean daily maximum temperature being about 40°C and mean daily minimum temperature being about 25°C. The heat in summer is intense. Maximum temperature may often go to about 46°C on some days. Scorching dust-laden north

westerly winds which are common features during May and June contribute much to the discomfort. With the advance of monsoons, there is fall in temperatures but the nights continue to be quite warm. Weather during monsoon season is oppressive on account of high humidity varying from 64-82 % during July to September but in summer the relative humidity is very low, as only 22-48 %. After rainy season the nights become cooler although the day temperature may stay high, mean maximum being around 36°C. From November onwards the fall in temperature is rapid. January is the coldest month with mean maximum being around 24°C and mean minimum being around 1.8°C. During winter northwest cold winds bring down minimum temperature suddenly to about freezing point but only during a few nights when frost and fog are experienced in the plains.

- Atmosphere Pressure and Winds :

The annual range of atmospheric pressure is very low in the region, but due to sudden rise in temperature and resultant marked fall in pressure, the cyclonic rains or thunder storms are often witnessed. The winds are generally light. During major part of the year these winds are predominantly from northwest with exception of easterly to southeasterly winds that blow on some days during the summer season. Also in the southwest monsoon easterlies and southeasterlies prevail.

For a brief spell during winter and summer seasons the sky is generally moderately to heavily clouded but during the rest of the year the sky is mainly clear or only lightly clouded. Overcast sky of the monsoon season is a common feature.

2.5 CHANDIGARH PERIPHERY ZONE :

Defying Le Corbusier's design and dream, Chandigarh could not retain its identity as a fully planned urban island wrapped around by a green belt of countryside. Not only has there been considerable non-plan development within the city but also extensive haphazard growth has taken place on its periphery. There is a popular desire to find a place within or around this city of economic opportunity and ecological quality.

An onslaught on the rural periphery was feared right at the time of birth of the city. The Capital of Punjab (Periphery Control) Act was enacted in 1952 to pre-empt this. A peripheral zone was

delineated covering the territory upto a distance of (10miles) 16 km all around the master plan area. in 1962. the stipulated objective were to (i) check the expansion of the city beyond its planned site: (ii) prevent speculation in land; and (iii) provide green environs to the city beautiful (as Chandigarh is popularly called)..

Physiographically, the zone is a submountaneous tract, drained by a number of seasonal streams. Its traditional economic base has been agriculture but this is changing fast. Daily commuting for work is extensive now. This is directed not only to Chandigarh but also to other urban centres, such as SAS Nagar (in Punjab), Panchkula and Pinjore (in Haryana). The zone had a total population of 0.7 million in 1991; roughly 70% rural and 30% urban. They are in 496 villages and 7 towns in the zone.

The Chandigarh Periphery Zone has indeed been violated with impunity. The new developments are partly planned and partly autonomous. The pressure on Chandigarh's infrastructure continues to intensify. There is an urgent need to develop a new perspective for the future and an appropriate parameter for the emerging urban scene.

CHAPTER - III

CURRENT RANGE & STATUS OF BIODIVERSITY

3.1. URBAN BIODIVERSITY

For continued survival of species and natural communities which are important for the well beings of humans, all levels of biodiversity are required. The plants growing along roadsides and other open spaces which are not included under forests, plantations, and agricultural areas must also be recognised as important.

3.1.1 FAUNA OF CHANDIGARH :

Insects comprise three-fourth of the animal kingdom, more than 1.5 million species of insects are known and beetles alone are every fifth organism in the world.

More than 30000 species of insects belonging to about 9 orders and more than 30 families are reported from Chandigarh region. Insect fauna belonging to some group of insects of Chandigarh and its surrounding areas have been studied by the Entomology section of the Department of Zoology, Panjab University, Chandigarh. The researchers have handled important families from different orders such as ; Colioptera, Lepidoptera, Hymenoptera, Diptera, Hemiptera, Orthoptera, Isoptera, Odonata and have made observations on the taxonomy, biology, ecology and development of large number of insect species.

The studied insect fauna of Chandigarh region includes about 2000 species of Beetles, 100 species of Butterflies, 300 species of Moths, about 70 species of Bees and Wasps, 62 species of Ants, 60 species of Dragon and Damsel flies, 50 species of Gryllids, 44 species of Grasshoppers and about 60 species of Flies.

The different zoological types in the region are :

- (a) Fishes : *Pisces* : In the small and large water bodies there are about a dozen types of fishes, of Thail (*Catla catla*) and Rohu (*Labeo rohita*) are well sought after.
- (b) Frogs and Toads : (Amphibia) : The common frog is *Rana tigrina* (Indian Tiger Frog) but the other ones are Indian Rice Frog and Indian Burrowing Frog. The common toad of the region is *Bufo melanostictus*.
- (c) Reptiles : Two types of tortoise are found. Lizards of 3-4 types are found in buildings, lawns, hedges, etc. and one of these attracts the attention by its brilliant vermilion colour during mating season. Snakes are of quite a many types as Russels Viper, Cobra, Blind Snake, Indian Python, Sand Cobra, Rat Snake etc.
- (d) Birds : (Aves) : These are of numerous types and the permanent population may consist of over 100 different kinds. There are also migratory birds visiting during winter from as far off a region as Siberia. These primarily visit Sukhna Lake and their estimate varies from 100-200 type of birds. The number of migratory birds varies from year to year.

(e) Mammals : Common ones are Grey Musk, Shrew Monkey, Langur, Flying Fox, Tickell's Bat, Stripped Squirrel, Indian Rat, Common Rat, House Mouse, Indian Porcupine, Indian Hare, Common Mongoose, Stripped Hyena, Jackal, Indian Fox, Nilgai, Blackbuck, Sambhar and Chital. When dhak (*Butea monosperma*) forests were existing in the terai region along the course of Choe (till the end of World War II) occasionally tiger or leopard would come down the Shivalik Forests during winter.

3.1.2 FLORA OF CHANDIGARH :

The flora of Chandigarh area is in fact very rich and a complete inventory made by Sharma & Sharma (1966, 1967, 1968) revealed the existence of 860 species of flowering plants in Chandigarh and its neighbourhood. These represent 526 genera from 116 families. Nearly 80 percent of the species belong to dicotyledons. Gramineae, Papilionaceae, Compositae, Cyperaceae and Euphorbiaceae are more common, being represented by 92, 83, 49, 36 and 33 species respectively. This excludes the ornamental species whose number is anybody's guess because amongst the residents of Chandigarh and neighbouring areas garden culture and love for ornamental herbs and shrubs is fast growing.

3.1.3 Medicinal Plants of Chandigarh region :

According to recent WHO studies 65% of population is still dependent upon traditional systems of medicine including Ayurveda, Siddha, Homeopathy and Herbal Medicines and all these systems are dependent on plants with medicinal value. Most of the medicinal herbs/plants are facing extinction due to over-exploitation by Pharma industry, lack of infrastructure and Government's apathy, changed global and climatic conditions.

Chandigarh region is rich in green flora and is home to number of plant species with Medicinal importance. Areas like Shivalik Reserve Forests, Sukhna Catchment area, Rock Garden, Rose Garden, adjoining villages, are among the various places in and around Chandigarh region, from where a local enthusiast Dr. Amrit Pal Singh, identified and collected around 43 different kinds of Medicinal plants, with special emphasis to endangered species. Detailed list is enclosed as Annexure-III.

3.1.4 TREES OF CHANDIGARH :

The most fascinating feature of the City's landscaping is perhaps the Tree Plantation along avenues, open spaces, green belts and around building complexes. The total forest cover in Chandigarh is 32.42 sq. km. which forms 23.5% of the total area. The green spaces like Parks, Gardens, Green belts, Leisure valley and Road avenues etc. are in addition to the forest cover of 23.5 %. Thus the green cover in the city is more than 33 % which is a good sign. In a book 'Trees of Chandigarh', jointly published by Chhatar Singh, Rajnish Wattas & Harbir Dhillon, the authors had listed a total of 26 types of flowering trees and 33 types of evergreen trees in Chandigarh. A detailed list is attached as Annexure -IV.

From viewpoint of bio-aesthetics careful plantations have been envisaged and done for the Leisure valley, Rajindra Park, Raj Bhawan Gardens, Sukhna Lake and other public parks within the Chandigarh city. Forest Department of Chandigarh have made large scale plantations in Sukhna Lake-High Court area *Dalbergia-Acacia* with principle species being *Dalbergia sissoo*, *Acacia catechu*, *A. nilotica*, *A. modesta* and *Prosopis juliflora*. In order to check siltation in Sukhna Lake a number of small village were got vacated and are had been closed for grazing. Afforestation operations carried during the last 25 years consisted mainly in sowing *Acacia catechu* in contour trenching and plantations of *Eucalyptus* in *choe valleys* with later on mixing of *Bombax ceiba*, *Lannea coromandelica*, *Moringa oleifera*, *Acacia modesta* and *Albizia lebeke* in the reserve forest of Sukhna Catchment area.

3.2 Microbial (Bacterial & Fungal) diversity of Chandigarh :

3.2.1 Bacterial diversity of Chandigarh :

Microorganisms are remarkably ubiquitous and are present almost everywhere, in soil, in water, in air, on the surface and inside of animals and plants. They are present in extremes of environments where other life forms cannot survive. They may be found in icy continent, some live at high temperature (like hot spring and hydrothermal vents), highly acidic or highly alkaline habitats and many survive in conditions where there is no oxygen. In short, it is difficult to find a natural system on earth where microbes do not exist. Although very small in size, part played by this group of organisms in overall ecosystem is very vital.

It may not be difficult to appreciate the diversity of microbes, how useful and important they are to deserve rightful attention of conservation strategists. It is clear that the wealth of microflora contributes as much as other life forms in the biological diversity of this planet.

Microorganisms are an important component of biosphere and their diversity is awe-inspiring. They are known to "

- a) provide a vast and largely untapped resources for mankind
- b) perform recycling roles
- c) interact with other living forms in ways that we are only now beginning to understand.
- d) provide basic materials for the development of pharmaceutical drugs, agrochemicals, bioremediation, biocontrol agents and products for other industries.

Conservation of this enormous wealth is very important for sustenance of life on this planet. A detailed list of Micro-organisms found in Chandigarh is enclosed as Annexure-V.

3.2.2 FUNGAL BIODIVERSITY OF CHANDIGARH :

Chandigarh situated in the foot hills of Shivaliks abounds with diverse groups of fungi belonging to myxomycota, oomycota, chytridiomycota, ascomycota and basidiomycota. (Prasher 1998*). This preliminary survey of the area revealed the presence of macro fungi (belonging to ascomycota and basidiomycota) like species of *Termitomyces* Heim, *Agaricus* L., *Volvariella* Speg., *Pleurotus* (Fr.) Kummer, *Coprinus* Pers., *Agrocybe* Fayod, *Collybia* (Fr.) Staude, *Lepista* (Fr.) Sm., and *Auricularia* Bull. ex. Juss. are edible and others like species of *Psilocybe* Fayod are poisonous and the species like *Ganoderma lucidum* are medicinally important although they are not edible.

The aquatic fungi like *Saprolegnia parasitica* (Pathogen of fish and eggs), *Leginidium* spp. (Parasite of Mosquito larvae) and *Aphanomyces* spp. are few of the economically important water-moulds which play an important role in productivity of the aquatic ecosystem like Lake eco-systems. Studies on the seasonal variation of aquatic fungi in Lake eco-system have revealed the occurrence of different groups of fungi at different temperature regimes and the effect of biotic and abiotic factors on their distribution (Prasher 1999). Due to biotic and abiotic disturbances in the study area there is a need to conserve the fungal biodiversity from extinction. The *in vitro*

conservation of these fungi (edible, medicinally important, as aid in bio-control agents) will help in their exploitation for cultivation and other beneficial use in a sustainable manner. The fungi will be characterised for growth parameters. The cultures of these fungi will be deposited at the Institute of Microbial Technology (IMTECH), Chandigarh in Microbial Type Culture Collection (MTCC) which is recognised for culture of microorganisms.

* Prasher, I.B. (1998) FUNGI OF CHANDIGARH. I.B.D. Dehra Dun pp. 167

3.3 DOMESTICATED BIODIVERSITY OF CHANDIGARH :

Although due to day by day increasing urbanisation and resultant decrease in green cover and conversion of agricultural fields into plots for residential purposes, the area under agriculture has decreased considerably in Chandigarh. But in many villages enterprising farmers are carrying on the tradition. The main cropping seasons identified are the (i) Kharif and (ii) Rabi.

Monoculture plantation i.e. only Rice and Wheat cultivation as is commonly practiced in Punjab, is practised in Chandigarh also. But in small pieces of land a variety of crops which includes food grains, sugarcane, vegetables and fruits are also cultivated. A list is enclosed as Annexure - VI.

3.4 LAKE ECOSYSTEM

The picturesque Sukhna Lake, a significant water feature of city beautiful was completed in 1958 by constructing a dam across Sukhna Choe downstream at the confluence of the two seasonal tributaries, namely Kansal and Suketri (Ghareri & Nepli tributaries) choe. The reservoir of lake is in the shape of a bean seed bounded by a 12.6 m high rockfill earthen dam. On the southeast corner of the lake a three-span spillway with crest at RL 349.91 m has been provided. At the time of construction the pondage capacity of the lake was 10.74 million cubic mtrs. with 2.28 sq. km. spread area. As per latest assessment, the pondage capacity (water holding capacity) has reduced to 4.2 million cubic mtrs. as the water spread area at RL 353.87 mtrs. has reduced to a mere 1.52 sq. km.

Wetlands are transitional areas (ecotones) between terrestrial and aquatic ecosystems and generally result in the development of distinct communities. The water table of wetlands is usually at or near

the surface and the land is temporarily or permanently covered by shallow water. The interactions of the ecotonal communities of wetlands not only regulate the water quality and the aquatic resources but also play a significant role in the maintenance of bio-diversity. Wetlands are, therefore, an important component of the ecosystem and have a definite role to play in the development of forestry, wild life, fishery etc. and have also an impact on the development of the society around.

Wetlands have many advantages for the community. They retain the rain water and thus reduce the severity of floods. They mitigate pollution by trapping sand and retarding silt inflow, materialising organic matter, reducing toxic material etc. They are an ideal habitat for diverse flora and fauna. They serve as the ground water reservoir, sanctuary for birds, development of fisheries etc. They provide sports and recreational facilities. It, therefore, becomes imperative on us to protect and properly manage the wetlands.

The common water weeds of Sukhna are not many. Only a few species of grasses (mainly *Typha*) and sedges, Hydrocharitaceae and Ceratophyllaceae, although over 1000 species of wild flowering plants have been reported from Sukhna catchment area. Many of these grow on the lake margins and even the lake bed as weeds. Trees, bushes and herbs are in plentiful in the vicinity of the lake. (number of species given below) :

Plants : Aquatic -11, Terrestrial - 30

Animals : Protozoa-34, Annelida - 26, Anthropoda - 650 (Crustacea-17, Myriapoda-3, Insecta-630), Platyhelminthes-1, Aschelminthes (Rotifera)-28, Mollusca-13, Pisces-37, Amphibia-4, Reptilia-13, Aves-129, Mamalia-45.

Fishes : Sukhna wetland, ponds and ditches in Chandigarh are inhabited by 37 species of fishes including Indian major carps and a few exotic carps. The fish fauna of U.T. Chandigarh is introduced from nearby areas and has close affinity with western Himalyan element. The catch statistics and experimental fishing have shown that the exotic carps have an edge over the Indian carps as they can tolerate wide range of temperature (4-33°C), are omnivorous and voracious in feeding and have high reproductive potential breeding four times in confined water etc. The exotic carps are therefore, a potential threat to native carps.

Migratory birds : Sukhna Wetland receives a large number of migratory birds during winter months (October to March). In addition to the migratory birds from the temperate region, this wetland also receives local migratory birds from neighbouring hills of Himachal Pradesh, and plains

of Punjab and Haryana due to transit position of Chandigarh. Though Sukhna wetland is a poor host to birds as it does not provide an ideal perching site due to sparse growth of trees, high turbidity, less vegetation cover, scarce food etc. Occasionally also there is disturbance by the boats. As many as 129 species of birds belonging to 42 families and 15 orders have been observed. A detailed list is enclosed as Annexure - VII.

3.5 SUKHNA WILDLIFE SANCTUARY

The Sukhna Wildlife Sanctuary is a part of wider Shivalik Forest Area. And this region is storehouse of diverse faunal significance, which can boast of a range of forest types from tropical dry deciduous forest cover to scrubs. The Shivalik region was once an abode for goral, Sambar, spotted deer, barking deer and even tigers. Fossils unearthed from the Shivaliks indicate that about 14 to 20 million years ago, this region had large mammals like the Primitive hippopotamus (*Hexaprotodon*), Four horned Giraffe (*Shivatherium*), Elephant with downward curving tusks on the lower jaw (*Bos planifrons*) and (*Bos namadicus*), Buffalo (*Bubalus palaeindicus*), Blue bull (*Boselaphus namadicus*), Gorilla like creatures (*Dryopithecus*) and a Primitive hominid Ape (*Ramapithecus*) (Cornwell, 1968; Mackinnon and Mackinnon, 1974; Khatri, 1975; Randhawa, 1980).

Mammals :

Today the Shivalik region continues to harbour some important mammalian fauna such as Sambar (*Cervus unicolor*), Nilgai (*Boselaphus tragocamelus*), Wild boar (*Sus scrofa*), Barking deer (*Muntiacus muntjak*), Spotted deer (*Axis axis*), Hog deer (*Axis porcinus*), Monkey (*Rhesus macaque*), Common Langur (*Semnopithecus entellus*), Jackal (*Canis aureus*), Indian Fox (*Vulpes bengalensis*), Indian Hare (*Lepus nigricollis*), Porcupine (*Hystrix indica*), Pangolin (*Manis crassicaudata*), Jungle Cat (*Felis chaus*), Small India Civet (*Viverricula indica*), Small Indian Mongoose (*Herpestes edwardsi*), Grey Musk Shrew (*Suncus murinus*), Pale Hedgehog (*Paraechinus micropus*), Long eared Hedgehog (*Hemiechinus auritus*), Flying Fox (*Pteropus giganteus*), Fulvous Fruit Bat (*Rousettus leschenaulti*), Palm Squirrel (*Funambulus pennanti*), Soft furred field Rat (*Millardia meltada*), Indian Mole Rat (*Bandicota bengalensis*), Bush Rat (*Golunda ellioti*), Short tailed Bandicoot (*Nesokia indica*), Indian Gerbil (*Tatera indica*), Common house or black Rat (*Rattus rattus*), Brown spiny Mouse (*Mus platythrix*), Common Indian field Mouse (*Mus booduga*), House Mouse (*Mus musculus*), and the Long tailed tree Mouse (*Vandeleuria oleracea*) (Prashad, 1984; Prater, 1993; Luna, 1993).

Avifauna :

Chandigarh region of Shivalik hills is home to number of bird species like, Peafowl, Grey Partridge, Black Partridge, Cuckoo, Kaliz Pheasants, Warbler, Tailor bird, Red Jungle fowl, Golden oriole, Koel, Common quail, Bulbul, Blyth, Woodpecker, Hornbill, Nightjar, Vulture, Pigeon, Dove, Kingfisher, Barnowl, bats etc.

Reptiles :

The important reptilian fauna constitute Python (*Python molurus*) which is commonly seen in the region, the Cobra (*Naja naja*), Rat snake (*Ptyas muscosus*), blind snake (*Typhlina bramina*), Common Krait (*Bungarus caeruleus*), Monitor Lizard and *Varanus sp.* etc.

Flora :

At present it has around 180 big and small water bodies that are not only providing a lifeline to the lake but have also become perennial watering holes which animals of the sanctuary frequent to quench their thirst. In many of these the rain water remains expounded throughout the year and it has witnessed a proliferation of wildlife. Micro-climatic conditions of each dam have improved. There is a appreciable increase in the population of Peacocks, Red-jungle fowl, Partridge, Parrots, Spotted deer, Wild boar, Jacklas, Civet, Rabbit, Sambhar, Porcupine and wide variety of birds etc.

The Sukhna Wildlife Sanctuary in Shivalik hills is characterised by tropical dry deciduous forest with abundance of thorny species. The trees are of low height with xerophytes predominating. The tree canopy is more or less broken and tree heights seldom exceed 10 metres. The least disturbed patches of vegetation are on the northern slopes. Throughout the Shivalik range of Chandigarh region the thorny and spiny species dominate. The common are : *Capparis sepiaria*, *Flacourtia indica*, *Rhammus persicus*, *Zizyphus numularia*, (Jangli Ber), *Acacia catechu*, *A. leucoploea*, *A. modesta*, *Prosopis spicigera* and *Diospyros codifolia*, *Carissa spinarum*, *Zizyphus numularia* and *Capparis sepiaria* make impenetrable scrub vegetation at foot hills.

Such species as *Anogeissus latifolia*, *Bauhinia racemosa*, *Casia fistula*, *Lannea coromandelica*, *Woodfordia floribunda*, *Murraya koeingii*, *Nyctanthes arbortristis* (harshingar) are not rare in higher reaches. Where vegetation is thick and protected, *Bauhinia vahlli* and *Pueraria tuberosa* grow as conspicuous climbers and occasionally clumps of bamboo (*Dendrocalamus strictus*) may be seen. On dry exposed slopes *Dodonia viscosa* and *Adhtoda vesica* are conspicuous shrubby elements all over the lower hills.

The plantation stock in the Shivalik belt mainly consists of *Acacia catechu* & *Delbergia Sissoo* but *Eucalyptus spp.* also find their place not very often. *Bhabar* grass is the most important plantation crop of these hills as a measure of soil conservation and its use in rope making and paper pulp.

In the choe valley occasionally highly lopped trees of dhak are seen. Near inhabitations in these valley neem (*Azardirachta indica* or *Melia azardirach*), amb (*Mangifera indica*) and Pipal (*Ficus religiosa*) are often planted. Here, *Acacia nilotica* also grows in abundance.

Lantana is invading the lower parts of the sanctuary and at some places there are thick growths of lantana.

Soil and moisture conservation measures supplemented with enrichment planting and direct seed sowing have led to the establishment of good vegetation and forest cover over the erosion prone slopes of the Shivaliks. Development of water-bodies have improved the hydrological regime of the Wildlife Sanctuary thereby improving the microclimate of the region. Availability of moisture throughout the year in the choes have improved the vegetation which in turn has led to the overall habitat improvement in the Sukhna Wildlife Sanctuary. Habitat improvement has resulted into the proliferation of faunal elements in the sanctuary.

A study on the landform-vegetation relationship in the Chandigarh Shivalik Hills revealed some association between vegetation of the catchment area of Sukhna Choe, Patiali Rao and Jainta Devi Ki Rao with landform features such as hogbacks, cuetas, scrap-ringed hills, serrated-knife edged ridges, rills and gulleys, river terraces etc (Singh 1990b). It was concluded that by and large, there was no consistent relationship between landform and vegetation types. This may be mainly attributed to : (i) the recent geological formation of these hills and (ii) ecological degradation due to biotic interference spread over the last about 200 years. Certain features of soil-structure and vegetation relationship that emerged from these studies are as follows :

- (i) Sand-Clay (generally 2:1 mixture) : In wet zone *Saccharum spontaneum* and in dry zones *Saccharum bengalense* and *Zizyphus numularia*.
- (ii) Sand-Clay conglomerates with lots of moisture; *Saccharum spontaneum*.
- (iii) Shingle Bars : *Saccharum spontaneum*, *Zizyphus numularia*, sedges and grasses.
- (iv) Clay-Sand (generally 2:1 mixture) : Species of *Carissa*, *Adhatoda*, *Zizyphus* and *Acacia*.
- (v) Clay and Clay-Sand (dry) : *Butea monosperma*.

- (vi) Sand-Gravel-Clay mixture but without much of moisture in surface layers : *Dalbergia sissoo* and *Acacia catechu*.
- (vii) Shallow Clay with Boulders : species of *Zizyphus*, *Carissa*, *Adhatoda*, *Ahretria*, *Adina*, *Mallotus*, *Flacourtia*.
- (viii) Boulder Beds : *Acacia catechu* and species of *Adhatoda*.

CHAPTER - IV

PROBLEMS RELATING TO BIODIVERSITY

4.1 URBAN BIODIVERSITY

Beyond the immediate causes that threaten biodiversity, there are ultimate causes, such as human population growth, massive impact of economic activity, rapid urbanisation, enormous increase in pollution specially vehicular pollution, by far the biggest problem in protecting the biodiversity is habitat destruction.

For developmental activities, the sites have been cleared of vegetation. With increase in population and crowding, trees and lawns around houses, schools, and public places have been removed to yield place for building. With the growth of the city the vegetation has decreased but pollution has increased. Now, it is a well established fact that the automobile exhausts greatly damage the roadside vegetation. Also, the vegetation has undergone a drastic change in composition and

character. Native and original species have yielded to the ornamentals, mostly exotics. Urbanisation has not only changed the dynamics of natural vegetation but also has subtracted or added various kinds of plants. Resultantly, conditions have become such which favoured the growth of aggressive species as Congress grass in Chandigarh Conurbation. Therefore, urban vegetation primarily comprised of ornamental or shade trees, shrubs, climbers, herbs etc.

For healthy urban environment vegetation is mainly distributed in (i) interstitial plantation spaces between various constructions, (ii) parks and green zones, (iii) gardens and (iv) lawns. However, boundaries between these are arbitrary, generally depending upon local perspective. Sadly enough, in case of most of Chandigarh Urban Ecosystem, modern city conceptual planning as provided for in the Master Plan of Chandigarh has not been implemented. The sectors north of Madhya Marg are greener and well planned as compared to western and southern sectors.

4.1.1 ___ FAUNA OF CHANDIGARH :

Till date no major faunal survey of the Chandigarh region had been undertaken. Though in the Department of Zoology, Panjab University, Chandigarh students and faculty members had listed few species of faunal diversity of Chandigarh region, but this is not significant enough to through light in this vast area of concern. There is definitely a substantial decrease in number of house sparrows and other birds in Chandigarh city, but without any proper faunal survey and that to a regular intervals it is not possible to comment on endangered species that are reducing in number and also on species whose number is increasing. After the preliminary assessment one could tell the reasons for increase or decrease of particular species, reasons for the same could be;

- destruction of habitat.
- elimination of host plants
- increase or decrease in their predators/parasites or parasitids.

4.1.2 ___ FLORA OF CHANDIGARH :

Chandigarh being a modern and beautiful city should represent a proper blend of indigenous and exotic species and one should be complimentary to each other and also in view of susceptibility of certain species to diseases and pests, the practice of monoculture plantations should be avoided. The indigenous species are hardy, having long life span, more effective in pollution abatement and require little care and less water.

Sharma and Sharma compiled a list of 860 species of plants in Chandigarh during the years 1966-68. This list is now 42 years old and the intervening years have witnessed a lot of change in the vegetation of this region both in context and content. These changes and the absence of a check-list of flora for this region is a great hindrance in any meaningful representation of plant wealth of this region. A more comprehensive survey of flora of Chandigarh is immediately required to see which new plants have come in and which plants we lost.

There is a rapid depletion of these wild grasses and flowering plants due to destruction and shrinkage of their habitat. Necessary steps are urgently required to study pollinators of some wild flowering plants for their conservation and propagation.

4.1.3 MEDICINAL PLANTS OF CHANDIGARH REGION :

- Medicinal herbs have been used for centuries in health care system. In most of ancient systems of medicine formulations usually remained confined to one generation only as no one is ready to part with the information he/she have.
- Number of deficiencies exist in history of herbal medicines as no documentation is present and that which is available is scattered.
- Concerned Government Departments are not interested in raising funds for research in herbal medicines, ethnobotany, ayurveda or siddha.

4.1.4 TREES OF CHANDIGARH :

Hundreds of trees so meticulously planted and nurtured along roadsides during early years have been cut down year after year since 1980's for widening of roads and making of roundabouts. In the original planning of Chandigarh Mango groves (originally in the villages comprising the block area

of Chandigarh, constituted the Mango belt of Ambala District) were retained in the residential areas as well as along roadsides but gradually these trees have been eliminated.

Than there was more focus on ornamental and exotic varieties of trees and plants and the indigenous plant species are either neglected or get the back seat which may have adverse impact on the biodiversity of the region as Chandigarh is a small city with limited land area for conservation of biodiversity. The introduction and increase of exotic species will drive the local indigenous species to extinction. Most of the exotic species are flowering in nature, having less life span and less effective in mitigating the ill effects of air pollutants.

Extinction of tree/plant species is likely to destabilise the entire biocommunity leading to the extinction of other species. For example Chukrassia tree which is not endemic to the City has been planted on more than six roads and in almost all parks and green belts whereas the most beneficial indigenous trees like Neem and Peepal are very few in number.

There is no denying the fact that with the growth of Chandigarh there has been decline and deterioration in the vegetation in and around Chandigarh. According to Leedy *et al.* (1978) in the opinion of ecologists if cities become increasingly devoid of species and habitat diversity, then they tend towards an all prevailing monotony which in other systems ecologists recognise as leading to imbalance and disruption. There is no green buffer between adjoining cities i.e Panchkula, SAS Nagar and Chandigarh. Upland fringe developments as in the vicinity of Punjab Engineering College near Naya Gaon and from village Khuda Ali Sher to Kaimbwala have further spoiled the 'original plan of the City'.

Burning of leaves and other waste material :

There is a general practice to sweep and collect the dried leaves and other waste material by the road side or under a tree and burn it. Burning of such material not only cause air pollution but also damages the live tree and affects its growth.

4.1.5 Removal of Parthenium, Lantana Weed and Amarbel (Cascuta) :

Congress Grass (*Parthenium hysterophorus*), an exotic weedy species, over the years, has spread throughout the country as a major biological pollutant of the environment. This obnoxious weed has also invaded the Chandigarh region since mid-eighties and has now become a highly problematic weed. It also causes skin rashes, aggravates asthma, and inflicts several adverse effects on human health. It is number one problem crop of Chandigarh.

Parthenium and similarly Lantana grass are the weeds which adversely affect the growth of indigenous species. It is fast spreading and invades the new soil and prevent the coming up of local flora of the region. It, has an adverse impact on the biodiversity as it kills all kinds of undergrowth. *Amarbel* which is a parasite which covers the whole foliage of tree and eat it away, it is also invading trees in the city.

4.2 Microbial (Bacterial & Fungal) Biodiversity of Chandigarh :

4.2.1 PROBLEMS RELATING TO BACTERIAL DIVERSITY :

In the past there was no major programmes for study of microbial diversity. At present we have very preliminary and definitely incomplete knowledge of microbial diversity of Chandigarh region (and for that matter in whole of India) because no such systematic studies has been undertaken. Since microorganisms are not visible to the naked eye, they can not be studied in the field and laboratories with some minimum basic facilities are required for preliminary analysis in terms of isolation, characterisation and identification. For in-depth analysis of total microbial diversity of any environmental sample requires expertise in molecular taxonomy and more sophisticated laboratories.

Studies so far has been focused on medically or industrially important microorganisms which is only a very tiny fraction of total microbial diversity. The problem is compounded by the fact that conventional approach to study microorganisms need growth of the organisms. It is well accepted that most of the microbes in environmental samples do not grow on conventional medium. Molecular approach is the only method available at present to get a picture of total microbial diversity of a sample. Expertise and facility for doing this type of work in India is very limited.

4.2.2 FUNGAL BIODIVERSITY OF CHANDIGARH :

Till to-date no comprehensive analysis leading to conservation of fungal biodiversity of Chandigarh region; which is rich in diverse groups of fungi has been done. The immediate need is to initiate an exercise to floristically analyse the fungi of this area and their *in vitro* conservation. This will identify the wild germ plasm of commercially exploited edible fungi like *Agaricus*, *Pleurotus* and *Volvariella*. Besides, it will identify the non-cultivated but edible species of these and other fungi with good agronomic features.

The *in vitro* conserved germ plasm of other fungi can be exploited for other purposes like in medicine etc. The aquatic fungi can be tested *in vitro* for biological control of mosquito larvae leading to its field trial against the mosquito species prevalent in this area.

4.3 DOMESTICATED BIODIVERSITY OF CHANDIGARH :

In a public hearing organised at a local village Khuda Ali Sher, the farmers told that they are already helplessly entrapped in the existing government policy of selective subsidies and support price for selective crops. Though the farmers indicated a meek desire to abolish the use of chemical fertilizers and pesticides but to switch over to organic farming they need government support and guidance from Panjab Agricultural University. Increasing input costs due to deterioration of soil health leaves them with no option but to resort to only those crops where market support is available. Unsustainable life-styles are also an important contributory factor.

4.4 LAKE ECOSYSTEM :

The main issues related to development of Sukhna Lake are summarised below;

- 1.Heavy siltation of the lake ever since its inception.
- 2.Reduction in pondage capacity from 10.74 million cubic meter to 4.2 million cubic meter.
- 3.Reduction in water spread area from 2.28 sq. km. to 1.52 sq. km.

Heavy sedimentation in the lake has been a major cause of concern ever since its creation in the year 1958. All the seasonal rivulets and their tributaries originate in the steep slopes of the Shivalik hills which are ecologically fragile and unstable. The entire area is in the shape of rugged terrain, its face incised with gullies and numerous seasonal streams. The water table is deep. The soil is sandy, embedded with pockets of clay which is highly susceptible to erosion by run off water action. The degree of slope is steep with precipitous slopes. As such land slips in the upper area of the catchment are very common, especially during the rains. The major rainfall i.e. 80% is received during the month of July-August. The intensity of rainfall is more while the duration is small. Therefore, the rain drop impact, turbulent flow-off run off, exposed soil etc. are some of the prominent factors responsible for massive soil erosion and hill denudation. Whatever soil particles come in contact with rain water, these get detached from the land mass under the raindrop impact and carried by the runoff to be safely deposited in the bed of the lake.

It is not as if no preventive steps have been taken to arrest the silt inflow in the catchment itself. But the preventive measures in the catchment, though initiated in the early sixties, had their impact much later. The malady was very much known to the government right in the beginning. That is why the land in the catchment was acquired in phases and tree plantation work was taken up on this land. Major plantation schemes, however, could not be taken up before 1966 by which time lot of silt has already found its way to the lake. But even the well planned plantation schemes could not yield the desired results because it was a formidable task to achieve reasonable success rate in this difficult terrain. There are hundreds of small streams which made it impossible to sustain tree plantation. Therefore, it was decided to go in for soil conservation measures alongwith tree plantation schemes. In the early seventies soil conservation measures at a rather modest scale were taken up in the catchment. This is also the period in which famous Sukhomajri Water Shed Management Project was taken up on the upper head of Kansal Choe. Simultaneously in the area falling under the Union Territory of Chandigarh schemes of soil conservation were implemented on a steady and sustained basis and are being continued under various programmes. Side by side massive afforestation schemes have been taken up and successfully implemented in the last two decades or so.

As a result of various soil conservation measures and afforestation a sizable portion of the catchment area is stabilised and is covered under thick vegetation. Some of the steep slopes have also emerged as well-wooded pockets as a result of the availability of angle of repose after requisite treatment. A number of water bodies including silt retention dams have become available to wild life. The

seepage line has extended down along the relief. In fact, some of the streams are tending to become perennial. Due to regeneration of forest vegetation several perennial and palatable grasses have come up in the area. Edible fruits and drinking water are available to the birds and other wild life.

4.5 SUKHNA WILDLIFE SANCTUARY :

4.5.1 LOSS OF BIODIVERSITY :

A change in forest vegetation normally leads to a change in the nature of the soil and especially in the type of humus, an important factor particularly on the basis of lignin/cellulose ratio of organic matter it returns (Gupta 1983).

There have been vast changes in the vegetational cover of Chandigarh region. Previous accounts of vegetation of northwest India (Puri 1960, Puri *et al.* 1983, Duthie 1960) show that in the Shivalik Hills (i) the submontane zone had plenty of Sal (*Shorea robusta*) forests, (ii) in the foothill savannah there were scattered trees of simbal (*Salmalia malabarica*), dhak (*Butea monosperma*), Katha (*Acacia catechu*) and *Zizyphus* species with abundant growth of grasses, (iii) Sisham (*Dalbergia sissoo*) and *Acacia catechu* formed the main trees of riverine tracts (iv) in the foothills thick forests of *Cedrella toona*, *Cassia fistula*, *Albizia procera*, *Grewia oppositifolia*, *Ficus glomerata*, *Eugenia jambolana* (*Syzygium cumini*) and *Trewia nudiflora* flourished with plenty of under growth of evergreen bushes and climbers and occasional grooves of bamboos (*Dendrocalamus strictus*) and (v) under drier soil conditions mixed deciduous forests of babul or desi kikar (*Acacia nilotica*), *Terminalia*, *Anogeissus*, *Adina* and *Ougenia* were common.

On the basis of information available from revenue records, there is clear cut evidence of existence before and immediately after Independence of thick *dhak* forests along the margins of *choes* in the piedmont and upland plains of Punjab portion of the Chandigarh region. There were thick growths of Katha (*Acacia catechu*) trees and bhabar (*Eulaliopsis binnata*) grass in the Chandigarh Shivalik Hills in those days. Due to growing population pressure and developmental activities, these forests have been cut down entirely and there had been a complete change in physiognomy of these hills by the fifties of this century. Flora changes are greatly in evidence during nearly 45 years of developmental history of the Chandigarh region.

Along with the depletion of forest cover a good amount of fauna has also disappeared from the Sukhna Wildlife Sanctuary area. Wild bear and tigers which occasionally be seen in the foothills riverine forests of the region in the forties are almost extinct now.

All natural regeneration is choked by wild growth of Lantana. There is heavy proliferation of various species of Lantana which is invading the indigenous flora of Sukhna Wildlife Sanctuary.

Porcupine and Wildboar cause root damage. There is crop damage in the adjoining fields by wild animals like Blue bull, Sambar, Wild boar and Monkeys. This has exacerbated man-animal conflict situation.

There is decline in the population of vulture and vultures are almost on the verge of extinction.

4.5.2 SOIL LOSS :

Erosion in Shivaliks is nearly a century old problem (Glover 1946). But now, due to soil and moisture conservation measures suppld with enrichment planting and direct seed sowing over the exposed slopes, soil erosion is controlled to larger extent and now the rate of siltation of Sukhna Lake is almost negligible. Major reasons for loss of biodiversity in the area are;

- i) Agriculture
- ii) Encroachment of Forest Land
- iii) Poaching
- iv) Forest Fires
- v) Habitat destruction
- vi) Conversion

MAJOR ACTORS & THEIR ROLES IN BIODIVERSITY

5.1 The Government :

The government is a major stake holder and actor on the issue of biodiversity. Activities of the following departments are directly concerned with the issue -

5.1.1 Department of Forests & Wildlife :

The department is responsible for protection of existing wild biodiversity of the state. The department has, however, played a mixed role. The need to shift from exotic monoculture plantations to mixed plantations of native species has been realized in the past decade. However, positive steps have now been taken by the deptt. to protect the biodiversity of region.

5.1.2 Department of Horticulture :

The department has provided information on existing flora of the region. The department admits that in an effort to enhance the outlook of the city exotic varieties were introduced at the cost of desi varieties. A stark example is the loss of a large number of desi varieties of mango from Chandigarh region.

5.1.3 Department of Industry :

In view of the recent WTO regime the industries department has a major stake in the bio-resources. The department have not made any special efforts to promote biodiversity protection from pollution impacts of industries.

5.1.4 Department of Environment :

The department has played a mixed role in biodiversity conservation. Though the issue has been recognized as important, but nothing substantial on this aspect was done earlier. The Projects that the Department supported includes;

- A study of Trees of Chandigarh.
- Analytical studies of Aquatic ecosystem of Sukhna Wetland & Catchment area.
- A study of birds of Sukhna Lake.

Further, though actions to control air, water & soil pollution are being taken through the State Pollution Control Board, a major dent still needs to be made with respect to habitat/ecosystem conservation. Rawla et. al (1988) published data on Pollution of Drinking water of Chandigarh with Moulds and Bacteria. The Project was supported by Department of Science & Technology, U.T., Chandigarh.

Other departments which have a stake in or impact upon biodiversity include the Department of Science & Technology, Town and Country Planning, the Department of Irrigation & Power, the Department of Public Works, the Department of Rural Development and Panchayats, the Department of Urban Development and Local Government, Chandigarh Industrial & Tourism Development Corporation, Department of Health, Department of Education, Department of Transport, Department of Social Welfare and Women and Child Development Corporation.

5.2 Academic Institutions and R&D Bodies

The Panjab University, Institute of Microbial Technology, Post Graduate Institute of Medical Sciences and Government Medical College, Sector 32, Chandigarh have taken up several taxonomic studies in the region. Major contributions on the study of diversity of fish & insects of the region were done by Zoology Department, Panjab University, Chandigarh. The Department of Botany, Panjab University has contributed immensely in conducting taxonomic studies on fungi of this area.

5.3 The NGO's

The number of NGOs working in the field of environment in Chandigarh has increased tremendously in the last decade. However, very few NGOs have interest in issues pertaining to biodiversity. The important ones are Environment Society of India; Chandigarh, WWF-India,

Chandigarh branch; People For Animals, Chandigarh Chapter and Yuvsatta etc. But most of the NGOs have only recently started working on Biodiversity related issues and have yet not been able to make a major dent in biodiversity awareness

5.4 Industry & Corporate Sectors

The Corporate sector has perhaps never contributed towards biodiversity conservation. Industries set up on prime agricultural land have rather led to pollution of air, water & soil thus contributing towards biodiversity loss. The corporate sector, however, can greatly benefit from sustainable use of bio-resources especially with respect to food based industry and herbal medicinal & cosmetic products.

5.5 The Local Communities

The Local communities are the major stake holders in biodiversity conservation. But somehow in Chandigarh region specially in urban areas a lot is to be done to sensitise the people on biodiversity related issues. .

The farming community of Chandigarh region also has a strong relationship with agricultural biodiversity. Information on reasons of biodiversity loss in the state have primarily been collected from the farmers themselves during public hearing. However, they usually find themselves helpless to address the issue of increase in agricultural biodiversity.

The role of women also needs to be specifically recognized as women are repositories of traditional information and have a profound knowledge of local ecosystems. They are also important protectors of biodiversity as kitchen gardens are maintained by them, specially in urban areas

The role of Gram Panchayats is also important as Panches usually have an influence on the local community and can help mould their attitudes.

ON GOING BIODIVERSITY INITIATIVES

6.1 Greening Chandigarh Action Plan 2001-2002

The role of Forests in ecological balance, environment stability, bio-diversity conservation, food security and sustainable economic development have been widely recognised. The forest resources are under mounting pressure owing to increasing human and live-stock population. Pollution has been increasingly affecting the quality of air, water and land resources.

With the aforesaid in view, the Forest Department, Chandigarh Administration formed a Green Task Force in Chandigarh and Greening Chandigarh Action Plan 2001-2002 is a sequel to constitution of a 'Task Force' by Chandigarh Administration. It aims at planning and implementation of afforestation works in Chandigarh with a view to increase green cover as it has the potential to ameliorate the environment.

Greening Chandigarh Action Plan 2001-2002 has emphasised over the proper representation of the flora which is indigenous to the Chandigarh region. Main emphasis of the action plan was that

exotics should not be given weightage at the cost of indigenous species. Similarly the plan advised against the monoculture plantations due to its inherent ill-effects. The whole action plan revolves round the concept of biodiversity in urban forestry as well as in natural forest areas. A proper and judicious blend of exotic and indigenous tree species is advocated for urban forestry. Keeping in view the aesthetic environmental and pollution factors in the city, the plantation of exotic species in natural forest areas is discouraged. This Action Plan is a joint effort of all the greening agencies/departments of U.T. Chandigarh.

6.2 Setting up of a Botanical Garden

Chandigarh Administration is setting up a Botanical Garden over 180 acres of land near Sarangpur village. The process for acquisition of land has already been started. The botanical Garden will be established and managed with the following aims and objectives;

- (i) To conduct studies on the diversity of plant life.
- (ii) For ex-situ conservation of Plant diversity.
- (iii) It will function as living repositories of plant life of the whole country.
- (iv) Germplasm collection of economically and botanically important plant species.
- (v) Facilitate research in plant species and propagation & conservation.
- (vi) To create awareness amongst the general public, particularly students about plant life and the need to conserve it
- (vii) To function as a source of recreation for the people living in urban areas and sub-urban areas.
- (viii) To ameliorate the urban environment particularly with regard to pollution control.

Efforts will be made to plant the vegetation of all the following nine different geographical regions;

1. Western Himalayas
2. Eastern Himalayas
3. Indus Plains
4. Gangetic Plains
5. Central India
6. Deccan

7. Western Coast and Malabar
8. Assam
9. Bay islands of Andaman and Nicobar.

6.3 Microbial (bacterial & fungal) diversity related initiatives :

6.3.1 Bacterial diversity : At present not much work is being carried out in microbial diversity in Union Territory of Chandigarh. Institute of Microbial Technology, Chandigarh has taken initiative in collection and analyse environmental samples from Chandigarh region. It has excellent facility for such study and long term preservation of microflora. Microbiology department of PGI routinely analyse samples of patients and some medically important microbial cultures are also preserved there.

6.3.2 Fungal Biodiversity : The mycology laboratory of the Botany Department, Panjab University has collected and described about 200 species of fungi from Chandigarh (Prasher 1988). Studies are going on to describe and prepare a fungal flora of Chandigarh. In addition to this a detailed analysis of drinking water of Chandigarh was done (Rawla et. al 1988) which described pathogenic fungi and bacteria to humans.

CHAPTER - VII

GAP ANALYSIS

Based on the data presented in the proceeding chapters, gaps in information, vision, policy and legal structure, institutional and human capacities and awareness and education have been identified as under;

7.1 GAPS IN WILD BIODIVERSITY CONSERVATION :

7.1.1 Gaps in Information;

- i) Information gap exists between scientific knowledge available with researchers, local knowledge system of the people and information with the Department of Forest and Wildlife.

- ii) Inadequacies exist in information on base line data on both, species and genetic diversity, micro and macro habitats, species distribution and Importance value index, status of endemic and key stone species etc. Profiles of biologically important areas (both rich and eroded) need to be worked out.
- iii) In last two decades, a lot of changes in the urban fringes and biodiversity profile of the city have taken place. The management plan of the Forest Wildlife Sanctuary are to be prepared.
- iv) There is a lack of coordination on various research programmes. Information on various plant and animals species needs to be updated.
- v) Review mechanisms to assess the impact of developmental activities on biodiversity are absent.
- vi) Information dissemination mechanisms are poor.
- vii) Study of microbial diversity as an area of research has not got its due importance. Research work in this area needs a reasonably equipped microbiological laboratories. Expertise in fungal and bacterial taxonomy is also required to study microbial diversity. Unfortunately, this discipline has been in neglect for a long time.

7.1.2 Gaps in Vision :

The economic and ecological benefits of non-timber forest produce (especially availability of medicinal plants) have not been given due importance.

7.1.3 Gaps in Policy & Legal Structure :

- i) Though legal system exist, but there is general lack of implementation and awareness.
- ii) There is no policy of protection of biodiversity rich areas.

7.1.4 Gaps in Institutional and Human Capacity :

- i) General lack of understanding of importance of biodiversity conservation in all developmental works and projects.

- ii) Lack of scientific records of medicinal plants, their active principles, utility under different doses, distribution etc. and non-recognition of role of vaid and hakims on information available with them in this respect.
- iii) Lack of appreciation of biodiversity issues especially at the levels of politicians, administration and other administrative departments.
- iv) Lack of ethnobiological data.
- v) Lack of cross-sectoral research studies.
- vi) Very few NGO's concentrating on biodiversity issues.

7.1.5 GAPS IN LINKAGES :

There is a distinct lack of coordinated efforts by various departments in implementation of their programmes. Each stake holder has adopted a narrow vision so that at times certain actions are repeated (resulting in wastage of resources), whereas other actions are left out. Further, in some cases, actions by one department are antagonistic to that of the other. Hence, inter and intra-departmental coordination needs to be promoted through regular meetings and joint evaluation projects.

7.1.6 GAPS IN AWARENESS AND EDUCATION :

- i) Most educational, environmental awareness programmes lack biodiversity content. No information exists on importance of biodiversity in ecosystem stabilization.
- ii) There is lack of practical orientation in formal education.
- iii) There is not much participation of NGO's in biodiversity conservation programmes perhaps due to lack of scientific understanding of the issues.
- iv) Specific training and orientation programmes for development department personnel and awareness programmes for general public need to be taken up to ensure that the importance of biodiversity conservation is appreciated and adhered to.

7.2 GAPS IN DOMESTICATED BIODIVERSITY CONSERVATION :

- i) An information gap exists between local knowledge systems available with farmers and plant breeders and researchers etc. There is lack of awareness about crop diversity and local solutions employed by the farming community to increase soil fertility.
- ii) Diversity of cropping pattern as means of managing climatic risk and mixed cropping as means of protecting crops from diseases is not recognised and this has resulted in extensive use of farm chemicals.
- iii) Watershed management techniques remain unused and is not practised by farmers.
- iv) Only wheat and rice and a few other crops are promoted through the public distribution system. This has led to increase in demand for these crops and hence discontinuation of cultivation of other crops.
- v) The traditional knowledge of farmers about seed selection, preservation, storage etc. has been largely disregarded.
- vi) Institution need to document the contribution of biodiversity to sustainable agriculture. Participatory research programme need to be taken up.

STRATEGIES FOR BIODIVERSITY CONSERVATION

Since biodiversity conservation is essentially related to conservation of life support systems and encompasses various sectors, a multi-pronged and cross sectoral approach needs to be adopted for its promotion. The approaches delineated below are based on combined perceptions of the public at large, NGO's, GO's, academicians, scientists and researchers, farmers, professionals, and the industrial sector as gathered from public meetings, public hearing, personal interviews, meetings and discussions;

8.1 STRATEGIES :

1. Assessment of the status of existing wild and domesticated resources.
2. Efforts should be made to improve canopy density in Shivalik forest area. Natural regeneration of native species needs to be promoted besides promotion of under-storey herb and shrub vegetation. The spread of Lanatana has to be checked and alternatives to Lantana which can grow on degraded lands under stress conditions be identified.
3. Defining of criteria for economic evaluation of resources.
4. Promotion of multiuse functions of ecosystems.
5. Promotion of policies which ensure that the degree of use of a resource remains at a sustainable level and does not exceed natural renewal rate.
6. Developing technologies which are resource efficient and less resource intensive.
7. Inclusion of biodiversity conservation criteria in all developmental programmes and adopting mandatory provisions for carrying out prior strategic assessment of all plans and programmes.
8. **Creation of Biodiversity Conservation Fund** : A biodiversity fund to compensate the biodiversity loss should be created, Biodiversity compensation for development projects should be charged.

9. Optimising application of environmental impact assessment (with due emphasis on biodiversity issues).
10. Fostering public participation in policy decisions.
11. Incorporating biodiversity issues in formal and non-formal educational and awareness programmes and creating awareness on benefits of biodiversity conservation amongst all sections of the society (including students, women, government personnel, NGO's, industry, farmers, etc.).
12. Chandigarh Administrations Education Department should ensure incorporation of relevant biodiversity issues, especially local examples be incorporated in the syllabi so that students can relate to their immediate environment.
13. Fostering research programmes for inventorisation of existing biodiversity and its known uses, appropriate technologies for its management and criteria for evaluation.
14. Capacity building through training/orientation programmes on biodiversity issues for all sectors of society.
15. Priority should be given to preparation of a data base of existing wild and domesticated biodiversity and traditional knowledge systems
16. Ensuring institutional and financial support for biodiversity based programmes.

ACTION PLANS

9.1 URBAN BIODIVERSITY

9.1.1 FAUNA OF CHANDIGARH :

○ **FAUNAL SURVEY :** At present the immediate and foremost need is a faunal survey of the region with reference to its habitat and alternate hosts. A definite plan will be made to make a faunal directory of Chandigarh and also to carry out the faunal surveys at regular intervals of time. After the preliminary assessment one could tell the reasons for increase or decrease of particular species, reasons for the same could be;

- destruction of habitat.
- elimination of host plants
- increase or decrease in their predators/parasites or parasitids.

9.1.2 CHANDIGARH'S FLORA :

○ **FLORAL SURVEY :** Chandigarh, that has been acclaimed as a 'Garden City' world over, has a large number of flora. While it provide various benefits to the city - a systematic evaluation of its contribution to enhancing city's biodiversity needs to be undertaken.

○ **FLORAL DIRECTORY OF CHANDIGARH :** A documentation of all existing flora can be compiled into a Floral Directory of Chandigarh. The objective of this Directory would not

only be to document the type, species etc. of existing species and their characteristics - but also rate their biodiversity value in terms of the following possible parameters ;

- i) Ecological benefits-such as foliage mass, flowering, fruits etc.
- ii) Habitat of birds.
- iii) Habitat for mammals, insects and other organic life.

On the basis of above evaluation-it would be possible to identify the contribution of the existing flora in enriching the biodiversity of Chandigarh and to further enhance their value. This would also act as a guide for framing future schemes for greater bio-diversity in the city.

○ **INDIGENOUS SPECIES** : Sustained continuance, restoration and reintroduction of indigenous species amidst plantations will also trigger colonisation of these habitats by birds, butterflies etc. To restore the past biodiversity and enrich the original flora and fauna, efforts will be made to plant indigenous species like Peepal, Pilkhan, Neem, Aam, Jamun, Shisham, Bargad, Gular, Jungle Jalebi, Kikar, Khair etc.

○ **PROTECTED SPECIES** : There are some rare species in the city like *Plantanus orientalis*, *Ginkgo biloba*, *Crataeva religiosa*, *Hardwickia binata*, *Grewia optiva* etc. Efforts will be made to get all such species identified and declared as protected species.

○ **SACRED TREES AT RELIGIOUS PLACES** : The people have a bond of religion with some plants like Bamboo, Mango, Pipal, Banyan, Tulsi etc. The Pipal and Banyan is worshipped like Gods in temples. These two trees are also linked with various myths. Tulsi plant is also worshipped. Wood of the Mango is preferred for religious Hawans. The linkage of religious feelings with these trees have their natural sacred protection, so it is proposed to plants in Religious Places sacred species like Peepal, Neem, Banyan, Sita Ashok, Bael, Banana and Shivling Tree etc.

○ **GREEN BUFFER** : As envisaged in the master plan of Chandigarh, it is still not to late to make a green buffer between Chandigarh and adjoining cities of Mohali (in Punjab) and Panchkula (in Haryana). Green belt along Patiali Rao from Shooting range southwards should be made. Inclusion of seedling types of fruit plants will go a long way to encourage biodiversity in flora and fauna.

○ **MEDICINAL PLANTS OF CHANDIGARH REGION** : The herbal vendors, practitioners of traditional medicine, vaidas and hakims will be taken into confidence and given due

respect and recognition. The medication provided by herbal vendors or allied people will be tested on modern parameters. If suitable information is obtained it should be documented. An area of 5 acres will be demarcated specially for Medicinal plants in the upcoming Botanical Garden of Chandigarh. Continuous and sustained efforts will be made to popularise the importance of Medicinal plants/herbs through Symposiums, Workshops, Public meetings etc.

9.1.3 REDUCTION IN TRAFFIC DENSITY :

The traffic on all the Chandigarh city roads, particularly those connecting with adjoining States of Punjab and Haryana is heavy and continuous throughout the day. The city hosts more than half a million vehicles, over three-fourths being two -wheelers and around 200 vehicles on an average are daily added in this list, so the resultant pollution and its effect on biodiversity is another major cause of serious concern. For this following ways and means are suggested;

- **STAGGERING OF OFFICE/SCHOOL TIMINGS :** Staggering of office/school timings would significantly reduce the otherwise peak hour pressure on the roads.
- **STRENGTHENING OF PUBLIC TRANSPORT SYSTEM :** Similarly, there is an immediate need to strengthen the existing Public Transport System so that more and more people use public transports rather their own vehicles.
- **CAR POOL & A WEEKLY DAY OFF :** The ideas and strategies like Car pool, keeping a weekly day off for vehicles should also be emphasised. To start with Chandigarh Administration can show the way in this regard.
- **PROMOTION OF CYCLES :** Chandigarh is a small city and people don't have to cover large distances to reach their offices, factories, schools, colleges and other places of work. Moreover the city roads are not build for such an enormous number and different type of vehicles. So here the idea of '**VEHICLE FREE CITY**' can be tried and experimented effectively. For this promotional campaigns for use of Cycles as mode of transport should be launched to ensure a healthy and pollution free environment. Special **Cycle-tracks** should be made alongside all the major roads.

9.2 MICROBIAL DIVERSITY :

Microbial diversity and its importance should be emphasized at the college and university level. Faculty members should be encouraged, in the national interest, to take up research on microbial diversity. Since microorganisms are versatile and very adaptive in nature, participation of many investigators will be required for understanding the complex nature of microbial diversity. India has a bewildering array of microbes and it is about time we take stock of them before they are lost or other countries claim them as theirs.

○ **MICROBIAL DIVERSITY IN CURRICULUM:** The Panjab Universities should be persuaded to emphasise the area of microbial ecology, microbial taxonomy and diversity in their curriculum.

○ **FINANCIAL SUPPORT TO INVESTIGATORS :** In order to have some basic information on microbial diversity in the Union Territory of Chandigarh, some systematic survey is required. For this purpose faculty members of Microbiology Department of Panjab University may be approached. This type of study requires use of chemicals, other consumables (like petriplates, glassware etc.) and some basic instruments. It is, therefore, proposed that some funds are provided to the faculty members to encourage them to undertake such small projects.

○ **AWARENESS PROGRAMME :** Department of Environment should organize short awareness programme/workshop for school children.

9.3 DOMESTICATED BIODIVERSITY CONSERVATION :

The following strategies are proposed :

○ **NO FURTHER CHANGE IN LAND USE :** Prime agricultural land should not be allowed for other users like urban settlements and industry (this presently being done at various places in Chandigarh).

○ **DIVERSIFICATION IN 'PDS' FOOD :** The public distribution system should reflect food and crop diversity to increase demand of diverse crops. This would act as motivational tool for farmers to grow diverse crops.

- **INTEGRATED APPROACH** : Integrated pest management, traditional farming systems, bio-fertilizers and safe pesticides should be promoted.
- **VETERINARY CENTRES** : Veterinary Centres can be established in rural areas to support and promote local (desi) variety of cattles.
- **AWARENESS GENERATION ACTIVITIES** : For raising the awareness levels among the farmers Kisan Mela's, Cattle festivals, Crop Competition, orientation camps for farmers will be organised at regular intervals and a Model Floriculture Farm will be established.

9.4 LAKE ECOSYSTEM :

The scope of undertaking soil conservation measures in Sukhna Wetland & Catchment Area is quite vast, so that the entire area of Union Territory Chandigarh is effectively treated and maintained. The achievement of sustainable development is particularly important. The term sustainable development brings together two strands of thought about the management of human activities, one concentrating on development goals, the other on controlling the harmful effects of human activities on the environment. Since large number of migratory birds visit Sukhna wetland every year, it is desirable that some part of the wetland preferably the eastern side should have least disturbance.

For achieving the aforesaid objectives an Integrated Action Plan is the immediate need of the hour. The integrated action plan can in addition to desiltation and catchment area treatment shall take care of ;

- **Studying production, periodicity and distribution of plankton and nutrient cycling within the lake** : At present due to decrease in water depth and high turbidity the phytoplankton and zooplankton population have declined. It is very important that a detailed study on phytoplankton and zooplankton community w.r.t. environmental factors is made so that their productivity can be determined and maintained.
- **Two Separate Zones** : The lake should be divided into two zones or sectors, for recreation and sports purposes and for conservation of biodiversity. The part reserved for the

conservation of biodiversity should be declared as 'sanctuary' and its management should be under the control of a single agency like Department of Forests and another part of recreation and sports activities can be handled by Department of Chandigarh Industrial Tourism Development Corporation. The seasonal/month wise data on its physico-chemical characteristics, phytoplankton, zooplankton should be collected in order to understand its biodiversity, the interrelationship between different components for formulating the future strategies.

○ **Development of fisheries :** This will include development of fish seed farm, fish aquaria, studying interaction between fish species and plankton population and extension, training and research. Selective angling during different months should also be organised. The angling data should be analysed for fish production and monitoring.

○ **Engagement of consultant to study ecological structure of the Sukhna Lake :** The interaction between the hydrodynamic events and biological entities in lake is a complex phenomenon and depends on no. of variables. To define the complete ecological structure of the lake a highly competitive agency is required which shall define the status/ interaction of each and every biotic and abiotic component. This is also more essential as the physical characteristics of the lake are entirely different, it is a man made lake where the source of water input is only rainfall and consequent run-off from inhabited areas.

○ **Landscaping :** The existing infrastructure around the lake shall be developed to add more attraction as development of a 500m long esplanades on north (Lake Club side), placing of boulders, providing watch towers with binoculars, lighting, installation of fountain etc.

○ **Ecological regeneration :** Development of shallow water bodies in the forest in the immediate vicinity of the lake within fenced area and interconnecting the same with the lake to act as breeding grounds and place for spawning.

○ **Local Experts :** For the collection of data, monitoring, management the local scientists be involved so that regular and at definite intervals the data could be collected.

○ **Solid Waste Management :** The flux of tourists on the lake results in generation of considerable amount of solid waste on the lake and if not properly handled a considerable portion of

the same find its way into the lake by winds etc. Steps need to be initiated to provide facilities for the proper collection and disposal of solid wastes.

○ **Public awareness, training and education :** This is an equally important component of any such project where huge amounts of funds are being put and this may seem to be a wasteful expenditure to many. The awareness of lakes, their importance has to be done through various mass media approaching methodologies.

Sukhna Lake is the lifeline of the city of Chandigarh. It is here that one can understand the concept of achieving a harmonious wholeness between the man made environment and nature. The lake emerged as a unique spot true to the Principal of modern town planning. This natural reserve is not a luxury but a necessity.

9.4.2 BENEFITS :

The following benefits would be achieved when the Sukhna Lake is restored to its pristine glory :

- a) yield or support aquatic flora and fauna in the catchment shall also revive. The Sukhna Lake in its hey days supported 121 species of wild birds, 11 species of wild animals, 13 species of fish and 54 species of vegetation.
- b) attract migratory birds from temperate region. The migratory birds from the Temperate region as Pinttails, Shoveller, Common Teal, Wigeon, Mallard, Redbreasted Pochard, Large Cormorant, White Stork, Greylag Goose, Common Crane once were a common sight, however, the nos. has declined considerably these days.
- c) shall support the declining biological population of plankton, benthic fauna and macrophyton. The decrease in the said has led to loss of fisheries and consequence to this the number of migratory birds have declined.
- d) The hydrological and ecological role in charging and recharging the aquifers shall be resumed. Whereas the tubewells in the city daily pumped 20 million gallon of water the capacity now been reduced to 10 million gallon and the aquifer water reserve is further declining as recharge is not there.

e) The landscaping of the area shall be spruced up. The boat club, A cafe, an esplanades, an island for migratory birds, lush green parks, a swimming pool around the lake attracts hundreds of health conscious residents to exercise and relax in natural environs. the improvement and upgradation of these facilities shall add to the interest of the residents.

9.5 SUKHNA WILDLIFE SANCTUARY :

Sukhna Wildlife Sanctuary which represents the Shivalik Hill Ecosystem and other natural forest areas like Reserve Forests and Leisure Valley is the major repository of the Union Territory Chandigarh. Forest cover plays an important role in maintaining the ecology and hydrology of the region. As Shivaliks are highly degraded and prone to soil erosion, following conservation measures needs to be continued;

- **SOIL AND MOISTURE CONSERVATION :** Soil and moisture conservation measures like Check dams, minor gully plugging, silt retention dams, spurs, land terracing, grade stabilisers, choe training works etc.
- **AFFORESTATION :** Afforestation of degraded hill slopes particularly by direct seed sowing and enrichment planting.
- **STABLIZATION OF CHOE BEDS :** Stablization of choe beds by vegetative methods.
- **DEVELOPMENT OF MULTI-STOREYED FORESTS :** The natural forest areas like Reserve Forests, Wildlife Sanctuary and Leisure Valley should be developed as a multi-storeyed forests to act as the store house of bio-diversity. This will also increase the microorganisms including micro-flora responsible for soil fertility.
- **PROMOTION OF NATIVE SPECIES** Natural regeneration of native species need to be promoted besides promotion of under-storey herb and shrub vegetation.

- **PLANTATION OF FRUIT BEARING SPECIES** : The greater emphasis will need to be paid to manipulating and managing habitats for wildlife, including the plantation of fruit bearing species to attract avifauna and provide food for monkeys, langurs.
- **REMOVAL OF EXOTICS** : Removal of exotics, provision of waterholes, plantation of palatable and nutritious grasses for ungulates, etc.
- **SPREAD OF LANTANA** : The spread of Lantana has to be checked and alternatives to Lantana which can grow on degraded lands under stress conditions be identified. Lantana has taken over the natural vegetation, preventing regeneration.
- **CONSERVATION OF LOWER GROUP OF PLANT & ANIMALS** : As of now, the attention of the Department is focused on conservation of mammals and higher plants. This needs to be extended to other plant and animals especially lower groups as they are important components of the ecosystem.
- **ANIMAL CENSUS** : To obtain an idea of animal population trends, census figures are of the utmost importance. Therefore, it is highly recommended that in areas of good biodiversity, animal census be conducted.
- **FLORAL INVENTORY** : The Forest Department should make out a floral inventory of their region, annual census can be conducted to determine the presence and abundance of ungulates and/or predators.
- **STERILISATION OF ANIMALS** : Policy for selective culling/sterilisation of animals with high population be adopted in areas of high man-animal conflict.
- **MANAGEMENT PLANS** : Few of the protected areas are covered by management plans. One of the criteria by which conservation success can be determined is the design of adequate management plans for biodiversity protections for protected area. The quality and comprehensiveness of the plan is an important indicator of the management status of the protected sanctuary/area. A management plan should not merely consist of a budget and general background information on the park. A management plan for Sukhna Wildlife Sanctuary as well as other reserve

forest area should be prepared which can be operative for a period of 10 years subject to a review after 5 years. A comprehensive plan at a minimum must include the following elements;

- i) Priority areas for protection and management.
- ii) Geographical extent of the park and zoning requirements, including core and buffer zone management.
- iii) Objectives of the plan.
- iv) Land use planning for the region and regional socio-economic and biological factors impinging upon the management of the protected area.
- v) Budgetary allocation for the protected area.

○ **TRAINING OF FIELD STAFF** : Adequate and regular training for the Forest field staff should be made possible for the Wildlife Management, Census, Protection and regeneration of forests, soil and moisture conservation works etc.

○ **INVOLVEMENT OF LOCAL COMMUNITIES** : Local communities appear to be relatively indifferent to wildlife conservation. There needs to be much greater emphasis paid to creating awareness, not only amongst communities adjacent to Sukhna Wildlife Sanctuary but also the public as a whole. Efforts should be made so that local people can participate in the conservation and biodiversity related developmental activities. Nature related programmes should be initiated at mass level.

○ **CONSERVATION IN CURRICULUM** : Educational institutions like Schools, need to introduce conservation into their curriculum, emphasising for example, how the increase in urbanisation has adversely affected species of plants. The fragile condition of the Shivaliks, which are being denuded of their forest cover and the important role they play in maintaining hydrology of the region, can be explained through organising site-visits.

BUDGETARY PROVISIONS (FOR 10 YEARS)

10.1 URBAN FORESTRY :

10 Crore

- (a) Exploration/Survey of Flora & Fauna
- (b) Floral & Faunal Atlas of Chandigarh
- (c) Collection & Rearing of Medicinal Plants
- (d) Collection, Preservation & analysis of compounds in Botanical Garden
- (e) Preparation of Green Buffer Zone in southern part of Chandigarh
- (f) Establishment of Horticulture & Agriculture Museum

10.2 LAKE ECOSYSTEM :

2 Crore

- (a) Study of Microorganisms in aquatic life
- (b) Setting of Fish Aquaria & Fish seed farm
- (c) Conservation of Lake Ecosystem
- (d) Establishment of watch tower & water bodies

10.3 SUKHNA WILDLIFE SANCTUARY (Shivalik Ecosystem) : 15 CR.

- (a) Sustained continuance of soil & moisture conservation measures
- (b) Removal of Lantana & Parthenium
- (c). Development of water bodies
- (d) Census of wildlife & its repetition after every 3 years
- (e) Floral & Faunal study of wildlife sanctuary
- (f) Restoration & reintroduction of original flora & fauna of Shivaliks
- (g) Preparation of Management Plan
- (h) Continuance of fire-line cutting
- (i) Establishment of Wildlife Museum

10.4 DOMESTICATED BIODIVERSITY :

13 Crore

- (a) General biodiversity related awareness activities
(e.g. Kisan Mela's, Cattle fairs, Crop Competitions etc.)
- (b) Promotion of Bio-fertilizers, Safe Pesticides, Integrated Pest Management
- (c) Promotion of improved agricultural practices blended with traditional farming
- (d) Development of Model Floricultural Farm
- (e) Establishment of veterinary centre
- (f) Modernisation of Stray animal ponds

Total Budget for 10 years : 40 Crore

MAIN OUTCOMES OF THE PUBLIC HEARING

On March 25, 2001, as part of formulation of Bio-diversity Strategy & Action Plan for U.T., Chandigarh the People Participation Thematic Group constituted by the Steering Committee, Department of Environment, Chandigarh Administration in association with Yuvsatta (an NGO) organised a Public Hearing at village Khuda Ali Sher, Chandigarh, for farmers, Women and other user communities who are traditionally related to biodiversity. Around 200 people from a cross-section of village community participated in the event. Shri Ishwar Singh, Dy. Conservator, Forests cum Director, Environment, Chandigarh Administration chaired the Public Hearing.

MAJOR ISSUES :

1. Increasing use of pesticides and artificial manuring.
2. Lack of People Participation in management and upkeep of adjacent Kansal Reserve Forest Area.
3. Non-integration of agriculture and animals.
4. Monotonous Crop patterns.
5. Lack of awareness in farmers and user communities.
6. Insufficient entry/exit points in the fencing of forest area.
7. Insignificant job opportunities for local youth in forest area.
8. Increasing noise pollution.
9. Loss of birds/species indigenous to the area.

ACTION-PLAN SUGGESTED:

1. Gradual reverting to Organic farming.
2. Increase in people participation in management of the Kansal reserve forest area.
3. Steps to integrate agriculture and animals.
4. Diversification of crop patterns.
5. Holding of Kisan Mela's, Crop competitions and Orientation Camp for farmers.

6. Provision for more entry/exit points in the fencing of forest area.
7. Preference to local people in job opportunities in the forest area.
8. Stricter norms to control noise pollution.
9. Plant more trees indigenous to the area.

ANNEXURE - II

KEY PARTICIPANTS

1. MEMBERS OF STEERING COMMITTEE FORMED BY DEPARTMENT OF ENVIRONMENT, CHANDIGARH ADMINISTRATION FOR PREPARATION OF BSAP:

- 1.The Director, Environment Department, Chandigarh Administration.
- 2.The Director, Institute of Microbial Technology (IMTECH), Chandigarh
- 3.The Scientist 'SE', Department of Environment, Chandigarh Administration.
- 4.The Executive Engineer Horticulture, Engineering Department, Chandigarh Administration.
- 5.The Executive Engineer Horticulture, Municipal Corporation, Chandigarh
- 6.Prof. SP Vij, Department of Botany, Panjab University, Chandigarh
- 7.Dr. Parmod Kumar, Director, Institute of Development & Communication, Chandigarh.
- 8.Mr. Pramod Sharma, President, Yuvsatta (an NGO), Chandigarh.
- 9.Ms. Madhu Sarin, Environmentalist, Chandigarh.
10. Prof. Rajnish Wattas, College of Architecture, Chandigarh.
11. Dr. Satish Narula, Punjab Agricultural University, Ext. Counter, Chandigarh.

2 MEMBERS OF THEMATIC GROUPS :

Members of four Thematic Groups are as under ;

2.1 URBAN BIODIVERSITY GROUP :

1. Prof. PS Kaushal, Department of Botany, Panjab University, Chandigarh (Chair)
2. Mr. Ishwar Singh, Dy. Conservator of Forests-cum-Director Environment .
3. Prof. SP Vij, Department of Botany, Panjab University, Chandigarh
4. Ms. Madhu Sarin, Environmentalist, Chandigarh.
5. Prof. Rajnish Wattas, College of Architecture, Chandigarh.
6. Dr. Satish Narula, Punjab Agricultural University, Ext. Counter, Chandigarh.
7. Dr. Surinder Kumar, Scientist 'SD', MOEF, Chandigarh
8. The Executive Engineer Horticulture, Engineering Department, Chandigarh Administration.
9. The Executive Engineer Horticulture, Municipal Corporation, Chandigarh

2.2 SUKHNA LAKE ECOSYSTEM :

1. Prof. MS Johal, Department of Zoology, Panjab University, Chandigarh (Chair)
2. Mr. HS Mehta, Scientist 'SE', Zoological Survey of India, Solan.
3. Dr. Tapan Chakrabarti, Scientist, Institute of Microbial Technology (IMTECH), Chandigarh
4. Dr. IB Prasher, Department of Botany, Panjab University, Chandigarh
5. Ms. Madhu Sarin, Environmentalist, Chandigarh.
6. Chief General Manager, CITCO, Chandigarh
7. Prof. AS Ahluwalia, Department of Botany, Panjab University, Chandigarh

2.3 SUKHNA WILDLIFE SANCTUARY :

1. Mr. Ishwar Singh, Dy. Conservator of Forests-cum-Director Environment (Chair).
2. Mr. Pramod Sharma, President, Yuvsatta (an NGO), Chandigarh
3. Dr. Satish Narula, Punjab Agricultural University, Ext. Counter, Chandigarh.
4. Dr. Amrit Pal, BAMS, MD, Chandigarh.
5. Dr. (Mrs.) Satinder Dhillon, Principal, Dev Samaj College of Education, Chandigarh
6. Prof. SP Vij, Department of Botany, Panjab University, Chandigarh
7. Prof. RC Aggarwal, Scientist, Central Soil Conservation, Chandigarh.

2.4 PEOPLE's PARTICIPATION GROUP :

1. Mr. Pramod Sharma, President, Yuvsatta (an NGO), Chandigarh (Chair).
2. Mrs. Harjinder Kaur, Mayor, Municipal Corporation, Chandigarh
3. Air Marshal Randhir Singh, Retd., Chandigarh.
4. Maj. Gen. Rajinder Nath, Retd., Councillor, Municipal Corporation, Chandigarh
5. Brig. Kuldip Singh Chandpuri, Retd., Chandigarh
6. Ms. Payal Sodhi, People For Animals (PFA), Chandigarh Chapter.
7. Mrs. Sumitra Kant Gupta, Chandigarh.
8. Dr. Supriya, Social Activist, Chandigarh
9. Dr. Rajinder K. Singla, Botanist, Chandigarh
10. Mrs. Ved Nanda, Women Entrepreneur, Chandigarh
11. Mr. Aditya Prakash, Architect, Chandigarh
12. S. Gurdev Singh, Asstt. Director, SOSVA, Chandigarh
13. S. Prem Singh, Farmer, Vill. Khuda Ali Sher, Chandigarh
14. S. Dayal Singh, Former Sarpanch, Vill. Khuda Ali Sher, Chandigarh
15. Ms. Rajni Chopra, Journalist, Indian Express, Chandigarh.
16. Dr. SS Goindi, Naturopath, Chandigarh.
17. Ms. Madhu Sarin, Environmentalist, Chandigarh.

ANNEXURE - III

MEDICINAL PLANTS OF CHANDIGARH

Chandigarh is a type of city, which has been provided with rich green flora. Areas like Kansal forests, Sukhna lake, Rock garden and Rose garden are some places to mention where a number of medicinal plants can be seen growing under varying conditions. A local enthusiast Dr. Amrit Pal Singh, B.A.M.S., MD located/listed 43 varieties of medicinal plants and 21 herbs growing in the region. In addition to Chandigarh a number of villages around Chandigarh were also visited for locating medicinal herbs. Old people including Herbal vendors, Hakims and Vaidyas were consulted for regional names of the medicinal plants. A detailed list is as under;

S. No.	Scientific Name	Local Name	Place of Collection	Date of Collection
1.	<i>Ajuga bracetosa</i> 24.8.99	Kakamuti	Bhagamajra	
2.	<i>Abutilon indicum</i> 12.6.99	Knaghi booti	Maujpur	
3.	<i>Acalypha indica</i> 1.4.2000	Kuppi	Banur	
4.	<i>Achyranthes aspera</i> No. of times	Poothkanda	Chandigarh city	
5.	<i>Adhatoda vesica</i> 11.3.98	Basuti	Sohana	
6.	<i>Aegeratum conzoydies</i> No. of times	-	Common	
7.	<i>Anagallis arvensis</i> 16.6.98	Jonkmari	Sohana	
8.	<i>Bellis agyepita</i> 18.8.99	-	Burail	
9.	<i>Blumea lacera</i> 28.8.98	Kukurunda	Leisure valley, Mohali	

10.	<i>Boerhavia diffusa</i> 4.5.98	Poonarnav	Mohali
11.	<i>Cassia tora</i> 28.8.98	Chakmad	Chandigarh city
12.	<i>Chenopodium ambrosoides</i> 18.2.2000	-	Phase 7, Mohali
14.	<i>Chrozophora rottileri</i> 23.4.2001	Okra	Kansal forest
15.	<i>Cichorium intybus</i> 3.8.97	Kasni	Chandigarh city
16.	<i>Cissampelos pariera</i> 5.5.98	Patha	Climbing on Trees
S. No.	Scientific Name Date of	Local Name	Place of Collection
	Collection		
17.	<i>Clemone viscosa</i> 14.4.98	Hulhul	Khuda Lahora
18.	<i>Ranunculus sceleratus</i> 30.4.98	Bhandeer	Leisure Valley, Mohali
19.	<i>Dhatura alba</i> 12.3.2001	Dhatura	Common
20.	<i>Eclipta alba</i> 30.4.98	Bhangra	Common
20.	<i>Elephantopus scaber</i> 12.3.2001	Gobhi	Ropar Canal
21.	<i>Emilia sonchifolia</i> Chandigarh 4.6.97	-	Rock garden,

22.	<i>Euphorbia hirta</i> 19.8.98	Vaddi shun	Common
23.	<i>Euphorbia thymlifolia</i> No. of times	Dudhi	Open spaces
24.	<i>Evolvulus alsinoides</i> 14.3.99	Chuhakanni	Mohali
25.	<i>Fumaria officinalis</i>	Parpat	Open fields of Dhanas 3.1.99
26.	<i>Grangea madersaptan</i> 12.12.98	-	Burail
27.	<i>Helitropium indicum</i> 30.2.2001	Hathisund	Ditches in Sohana
28.	<i>Limnophila sp</i> Mohali 2.2.99	Brahami	Stagnant water in
29.	<i>Martynia diandra</i> Mohali 2.6.98	-	Waste places,
30.	<i>Plunchea lanceolata</i> 11.11.99	Rasna	Open grounds, Mohali
31.	<i>Polygonatum barbatum</i> 1.5.97	-	Mohali
32.	<i>Rumex sp</i> 3.1.99	Chuk	Badmajra
33.	<i>Saponaria vaccaria</i> 28.10.98	Machar phadi	Manakmajra
34.	<i>Sida cordifolia</i> 17.7.98	Khernti	Manakmajra

1.	<i>Euphorbia thmylfolia</i>	Vadi dudhi
2.	<i>Euphorbia hirta</i>	Chotti dhudi
3.	<i>Acalypha indica</i>	Kuppi
4.	<i>Phyllanthus niruri</i>	Phhui amla
5.	<i>Phyllanthus urinaria</i>	-
6.	<i>Terminalia belerica</i>	Baheda
7.	<i>Plumerea acuminata</i>	-
8.	<i>Terminalia arjuna</i>	Arjun
9.	<i>Basella alba</i>	-
10.	<i>Tribulus terrestris</i>	Gokhru
11.	<i>Solanum torvum</i>	Kandi
12.	<i>Solanum xanthocarpum</i>	Kandyali
13.	<i>Solanum surratense</i>	Variety of Kandyali
14.	<i>Physalis minima</i>	-
15.	<i>Spheranthus indica</i>	Mundi
16.	<i>Cannabis indica</i>	Bhang
17.	<i>Psoralea corlyfolia</i>	Bavachi
18.	<i>Sida spinosa</i>	Kanda khernti
19.	<i>Ligusticum diffusum</i>	Jangli ajwain
20.	<i>Ammannia baccifera</i>	-
21.	<i>Argemone mexicana</i>	-

MICRO-ORGANISMS FOUND IN CHANDIGARH

Few small scale projects in this area were done with specific objectives in mind. From the data available from these project reports following microorganisms (mostly bacteria) are known to exist in this region. Till now there has not been much systematic work has been done on microbial diversity in and around Chandigarh - UT, University departments of Microbiology, Botany and Zoology, Pathology and Dental department of GMCH, Microbiology, Pathology and Paediatric departments of PGI. This should be kept in mind that the known diversity is only proverbial tip of the iceberg. Proper systematic study from different environmental niches will reveal an enormous microbial diversity.

Microflora known to exist in sewage treatment plant in U.T. :

Algae: *Nostoc*, *Anabena*, *Phormidium*, *Oscillatoria*, *Chlorella*, *Scenedesmus*, *Chlamydomonas*, *Diatoms*, and *Euglena*

Fungi: *Penicillium purpurogenum*, *Cochilliobolus spicifer*, *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus terreus*

Bacteria: *Staphylococcus aureus*, *Streptococcus faecalis*, *Bacillus megaterium*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Proteus vulgaris*, *Shigella dysenteriae*, *Salmonella typhi*, *Pseudomonas aeruginosa*.

Bacteria found in Packed foods in Chandigarh

Staphylococcus aureus, *Klebsiella pneumoniae*, *Escherichia coli*, *Salmonella sp.* *Shigella sp.*
Sterptococcus faecalis

MEDICALLY IMPORTANT MICROFLORA FOUND IN U.T. REGION

Bacteria in blood samples

	<i>Gossypium arboreum</i> Linn.	Tree Cotton of India	
	Kapah		
	<i>Vigna mungo</i> Hepper	Black gram	
	Urd, Mah		
	<i>Oryza sativa</i> Linn.	Rice	
	Chawal, Jeeri		
	<i>Pennisetum americanum</i> Leeke	Pearl millet	
	Bajra		
	<i>Sorghum bicolor</i> Moench.	Sorghum	
	Jawar, Chari		
	<i>Zea mays</i> Linn.	Maize, Indian com	
	Makki		
	Rabbi Crops		
	<i>Brassica campestris</i> Linn.	Yellow sarson	Sarson,
Sarhon			
	<i>Brassica juncea</i> Czern.	Leaf mustard	
	Raya		
	<i>Eruca sativa</i> Mill.	Rocquette	
	Taramira		
	<i>Lens culinaris</i> Medik.	Potato, Irish potato	
	Alu		
	<i>Hordeum vulgare</i> Linn.	Barley	
	Jaun		
	<i>Triticum aestivum</i> Linn.	Wheat	Kanak,
Gehun			
	<i>Trifolium alexandrinum</i> Linn.	Egyptian clover	Barseen,
	Barseem		
	<i>Curcuma longa</i> Linn.	Turmeric	
	Haldi		

<i>Allium cepa</i> Linn.	Onion	
Piaz, Pyaz,		
	Ganda	
<i>Allium sativum</i> Linn.	Garlic	
Lassan, Thom		
<i>Beta vulgaris</i> Linn.	Beetroot, Garden beet	
Chukander		
<i>Beta vulgaris</i> Linn. var. <i>benghalensis</i>	Beet green, Indian spinach	Palak
<i>Brassica oleracea</i> Linn. var. <i>botrytis</i>	Broccoli, Cauliflower	Phul
gobhi		
<i>Brassica oleracea</i> Linn. var. <i>gongylodes</i>	Knol Khol, Kohlrabi	
Ganthgobi		
(syn. <i>Brassica caulorapa</i> Pask)		
<i>Brassica rapa</i> Linn.	Turnip	
Shalgam,		
	Gonglu	
Botanical Name	Common English Name	
Vernacular		
	(Punjabi)name	
<i>Daucus carota</i> Linn. var. <i>sativa</i>	Carrot	Gajar
<i>Coriandrum sativum</i> Linn.	Coriander	
Dhania		
<i>Pisum sativum</i> Linn.	Garden Pea	
Mattar		
<i>Lablab purpureus</i> (Linn.) Sweet	Hyacinth bean, Lablab, Bonavist	Sem
<i>Trigonella corniculata</i> Linn.	-	
Kasoori Methi		
<i>Trigonella foenum-graecum</i> Linn.	Fenugreek	
Methi		
<i>Lycopersicon esculentum</i> Mill.	Tomotto	Tamatar
<i>Spinacea oleracea</i> Linn.	Spinach	Palak

	<i>Abelmoschus esculentus (Linn.) Moench.</i>	Lady finger, Okra	Bhindi
Tori			
	<i>Vigna unguiculata (Linn.) Walp</i>	Cowpea	Lobia,
Rawan			
	<i>Citrullus fistulosus Stocks</i>	Round gourd	Tinda
	<i>Citrullus lanatus Mats. & Nakai</i>	Water melon	
Hadwana			
	<i>Cucumis melo Linn.</i>	Melon, Muskmelon	
Kharbooza			
	<i>Cucumis melo Linn. var. flexuosus</i>	Snake/Serpent melon, Long melon	Tar, Kakri
	<i>Cucumis sativus Linn.</i>	Cucumber	
Khira			
	<i>Cucurbita pepo Linn. var. melopepo</i>	Marrow, Summer squash	Vilati/Chappan
	kaddu		
	<i>Lagenaria sicearia (Molina) Standley</i>	Bottle gourd, Calabash cucumber	Ghia, Lauki
	<i>Luffa acutangula (Linn.) Roxb.</i>	Angled Loofa	Ribbed/ridged sponge
Kali/Ram Tori			
			gourd, vegetable sponge
	<i>Luffa cylindrica (Linn.) Roem.</i>	Smooth Loofa, Smooth sponge gourd	Ghia tori
	<i>Momordica charantia Linn.</i>	Bitter gourd	
Karela			
	<i>Capsicum annuum Linn.</i>	Chillies, Red pepper	Mirach
	<i>Solanum melongena Linn.</i>	Egg plant, Brinjal, Aubergine	Baingan,
Bataun			
	<i>Colocasia esculenta (Linn.) Schott.</i>	Taro, Dasheen	Arbi,
Kachalu			
	<i>Carica papaya Linn.</i>	Papaya, paw paw	
Papita			
	<i>Citrus aurantiifolia (Christm.) Swing</i>	Lime	
Kagzi Nimbu			
	<i>Mangifera indica Linn.</i>	Mango	
Amb			

<i>Psidium guajava</i> Linn.	Guava	
Amrood		
<i>Syzygium cumini</i> (Linn.) Skeels	Jambolan, Jambolan plum	Jamun
<i>Vitis vinifera</i> Linn.	Grapes	
Angoor		
<i>Zizyphus mauritiana</i> Lam.	Jujube, Chinese date	Ber
<i>Morus alba</i> Linn.	White mulbery	
Shahtoot		
<i>Emblica officinalis</i> Gaertn.	Emblic, myrobalan	
Aonla, Amla		

ANNEXURE - VI

TREES OF CHANDIGARH

According to a study conducted by Chattar Singh, Rajnish Wattas & Harjit Singh Dhillon on 'Trees of Chandigarh', following species were identified and listed ;

A. FLOWERING TREES :

The major twenty-six varieties of flowering trees in Chandigarh are as under;

<u>S. No.</u>	<u>Botanical Name of the Tree</u>	<u>Common Name of the Tree</u>
1.	<i>Acacia auriculiformis</i>	Australian kikar
2.	<i>Anthocephalus cadamba</i>	Kadam
3.	<i>Barringtonia acutangula</i>	Smunder phall
4.	<i>Bauhinia purpurea</i>	Kachnar
5.	<i>Bombax ceiba</i>	Simbal
6.	<i>Callistemon lanceolatus</i>	Bottle Brush
7.	<i>Cassia fistula</i>	Amaltas

8.	<i>Cassia javanica</i>	Java-ki-rani
9.	<i>Cassia siamea</i>	Kassod
10.	<i>Chorisia speciosa</i>	Mexican silk-cotton tree
11.	<i>Crataeva religiosa</i>	Barna
12.	<i>Delonix regia</i>	Gulmohar
13.	<i>Erythrina indica</i>	Indian coral tree
14.	<i>Grevillea robusta</i>	Silver oak
15.	<i>Jacaranda mimosifolia</i>	Nili gulmohar
16.	<i>Koelreuteria apiculata</i>	Koelreuteria
17.	<i>Lagerstroemia thorelli</i>	Queen's flower
18.	<i>Millettia ovalifolia</i>	Millettia or Rose wood
19.	<i>Parkinsonia aculeota</i>	Vedi-bathal or jorusalem thorn
20.	<i>Plumeria alba</i>	Gul-e-chin or pagoda
21.	<i>Saraca asoca</i>	Sita ashok
22.	<i>Spathodea campanulata</i>	Fountain tree
23.	<i>Tecoma argentea</i>	Tecoma Tree
24.	<i>Tecomella undulata</i>	Lahura
25.	<i>Terminalia myriocarpa</i>	Hollock
26.	<i>Thespesia populnea</i>	Tulip tree or Pahari pipal

B. EVERGREEN TREES

The major thirty-three varieties of evergreen trees in Chandigarh are;

1.	<i>Acrocarpus fraxinifolius</i>	Pink cedar
2.	<i>Adina cordifolia</i>	Haldu
3.	<i>Albizia procera</i>	White siris
4.	<i>Alstonia scholaris</i>	Devil's tree
5.	<i>Azadirachta indica</i>	Neem
6.	<i>Bischofia javanica</i>	Red Cedar
7.	<i>Cedrela toona</i>	Tun

8.	<i>Chukrasia tabularis</i>	Chukrasia
9.	<i>Diospyros embryopteris</i>	Ghab
10.	<i>Enterolobium timbouva</i>	Timbouva
11.	<i>Eucalyptus citriodora</i>	Safeda
12.	<i>Eugenia cuspidata</i>	Jamoa
13.	<i>Ficus benghalensis</i>	Burr, Bohar, Bargad, Banyan
14.	<i>Ficus benjamina</i>	Golden fig
15.	<i>Ficus infectoria</i>	Pilkhan
16.	<i>Ficus religiosa</i>	Pipal or Bodhi tree
17.	<i>Heterophragma adenophyllum</i>	Marorphalli or Monkey tail
18.	<i>Kigelia pinnata</i>	Jhar fanoos or balam khira
19.	<i>Magnolia grandiflora</i>	Bara champa
20.	<i>Mangifera indica</i>	Mango
21.	<i>Millingtonia hortensis</i>	Akash-nim
22.	<i>Mimusops elengi</i>	Moulsari
23.	<i>Polyalthia longifolia</i>	Ashok or Mast tree
24.	<i>Pongamia glabra</i>	Papri
25.	<i>Pterospermum acerifolium</i>	Kanak champa
26.	<i>Putranjiva roxburghii</i>	Jiva putra
27.	<i>Sapium sebiferum</i>	Makhan tree
28.	<i>Schleichera trijuga</i>	Kusum
29.	<i>Sterculia alata</i>	Pinari or Budha's coconut
30.	<i>Swietenia mahagoni</i>	Mahagony
31.	<i>Tamarindus indica</i>	Imli
32.	<i>Terminalia arjuna</i>	Arjun Tree
33.	<i>Terminalia bellirica</i>	Bahera

Annexure VIA

Fruit Trees of Chandigarh

Sr.No.	Name of the Fruit Plant	Botanical name
1.	Mango	Mangifera indica
2.	Litchi	Litchi chinensis Sonn
3.	Chicku	Achrus sapota
4.	Guava	Psidium guajava
5.	Pear	Pyrus species
6.	Peach	Prunus persica
7.	Plum	Prunus communis
8.	Grapes	Vitis vinifera
9.	Ber	Zizyphus jujube
10.	Loquat	Eriobotrya japonica
11.	Papaya	Carica papaya
12.	Pomegranate	Punica granatum
13.	Phalsa	Grewia asiatica
14.	Mandarin (santra)	C. reticulata
15.	Sweet Orange	C. sinensis
16.	Grape fruit	Citrus paradisi
17.	Lemon	C. limon
18.	Lime	C. aurantifolia sowing
19.	Sweet lime	C. limettirides
20.	Date	Phoenix dactylifera
21.	Custard apple	Annona squamosa
22.	Mulberry	Morus sp.
23.	Fig	Ficus carica
24.	Jac fruit	Atrocarpus hetesophyllus
25.	Bael	Aegle marmelos
26.	Almond	Prunus amygdalis linn

27.	Prunes	
28.	Crab apple	
29.	Amla	<i>Phyllanthus emblica</i>
30.	Banana	<i>Musa paradisiaca</i>
31.	Jamun	<i>Syzi ygium</i>
32.	Karondan	<i>Carussa carabdas</i>
33.	Straberry	<i>Fragaria species</i>

FRUITS

1.	Citrus psylla	<i>Diaphorina citri</i>
2.	Citrus leaf-miner	<i>Phyllocnistiscitrella</i>
3.	Citrus whitefly	<i>Dialeurodes Citri</i>
4.	Citrus black fly	<i>Aleurocanthus woglumi</i>
5.	Citrus leaf-folder	<i>Psorosticha-zizyphi</i>
6.	Mites	
7.	Bark-eating caterpillar	<i>Indernetasp</i>
8.	The mango mealay-bug	<i>Drosichae mangigera</i>
9.	Mango hoppers	<i>Amaritodus atkinsoni</i> and <i>Idioscopus sp</i>
10.	Leaf-hoppers and aphids	
11.	Hairy-caterpillar	<i>Cuproctis sp.</i>
12.	Mite	<i>Eutranychus orientalis</i>
13.	Bark eating caterpillar	<i>Inderbela quadrinotata</i>
14.	Peach-leaf-curl aphid	<i>Brachycaudus helichrysi</i>
15.	Peach black aphid	<i>Petrocelours persicae</i>
16.	Chaffer and other defolia.ting beetles	
17.	Plum case worm	<i>Ceramastopsychae pendula</i>
18.	Hairy caterpillar	
19.	Peace fruit fly	<i>Dacus dorsatis</i> Hendel
20.	Grapevine thrip	<i>Rhipiphorothrips cruenlatus</i>
21.	Jassid	<i>Arboridae viniferata</i>
22.	Yellow and red wasps	<i>Polistes hebraens</i> and <i>Vespa</i>

		orientalis
23.	Leaf-roller	Sylepta lunalis
24.	Defoliating beetles	
25.	Fruit fly	
26.	Fruit-fly	Carpomyiavasuviana
27.	Leaf-eating caterpillar	
28.	Lac insects	
29.	Aphids	
30.	Fruit borer	
31.	Powdery mildew	Erysiphe polygoni
32.	Wilt, Root rot and colar rot	Fusarium oxysporum and Rhizoctonia solani
33.	Rust	Uromyces viciae fabae
34.	Damping off	Pythium sp., Rhizoconia sp. And Fusarium sp.
35.	Crown rot of turnip	Alternaria brassicae
36.	Black rot	Xanthomons
37.	Alternaria blight	Alternaria brassicae and A.Brassicicola
38.	Downy mildew	Poronospora parasitica
39.	Stalk of cauliflower seed crop	Sclerotinia Sclerotiorum
40.	Cercp/pra leaf spot	Cercospora beticola
41.	Late blight	Phytopathora infestans
42.	Early blight	Alternaria solani
43.	Black-scurf	Rhizoctonia solani
44.	Charcoal	Macrophomina phaseolina (Rhizoctonia bataticola)
45.	Mosaic and leaf roll	Different virus (S)
46.	Common scab	Streptomyces scabies
47.	Leaf spot	Dercospora solani tuberosi

FLOWERS

1.	Wilt and collar rot	Fusarium oxysporum
2.	Storage rot of corms	Fusarium oxysporum and species of many saprophytic fungi (Alternaria, penicillium, Aspergillus etc.)
3.	Leaf spot	Septoria chrysanthemella phoma chrysanthemella

FRUITS

1.	Canker	
2.	Scab	
3.	Gummosis	Foot-rot
4.	Wither tip	Anthraco nose
5.	Virus and Virus like diseases; (i)Greening (ii) Tristeza	Virus iii) Exocortis (viroid)

Annexure VIB

Pests of Fruit, Vegetable & Flowers found in Chandigarh

Insect Pests of Musk-melon, water melon and other cucurbits

Sr.No.	Name of the Insect	Common name
1.	Red pumpkin beetle	Raphidopalpa faveicollis
2.	Aphid and Jassid	
3.	Spider mite	Tetranychus cucurbitae
4.	Fruit-flies	Dacus cucurbitae

TOMATO

1.	Jassid	Amrasca biguttula and white-fly (Bamisia tabaci)
2.	Fruit borer	Heli-coverpa armigera

BRINJAL

1.	Jassid, hadda beetle and brinjal fruit and shoot borer	
2.	Spider mites	

BHINDI

1.	Jassid and spotted boll worms	
2.	Spider mites	

BELL PEPPER (SHIMLA MIRCH)

1.	Thrips, mites, aphids and whitefly	
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COWPEA

1.	Jassid/aphids	
2.	Pod borer or Blue butter fly	

GARLIC

1.	Onion thrips	Thrips tabaci
2.	Onion maggot	Hylemyia antiqua

PEA

1.	Pea thrip	Thrips indiscus
2.	Pea-leaf miner	Phytomyza atricornis
3.	Pea-aphid	Acrythosiphonpisum
4.	Pea-stem fly	Ophiomyia

Cauliflower, Cabbage, Broccoli, Chinese cabbage, Radish and turnip

1.	Stem borer	Hellulaundalis
2.	Diamond-back moth	Plutella xylostella
3.	Tobacco caterpillar	Spodoptera litura

BETTLEAF (PALAK)

1.	Aphids	Aphids sp.
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POTATO

1.	Jassid and Aphid	Autumn crop
2.	Tobacco Caterpillar	Spring cop
3.	Cutworm	Agrotis sp.
4.	Aphids	

ANNEXURE - VII

BIRDS OF CHANDIGARH

In Chandigarh region 129 species of birds belonging to 15 orders and 42 families have been recorded. Areas like Panjab University Botanical Gardens, Sukhna Lake and Sukhna Wildlife Sanctuary are ideal sites for bird watching.

