CASE STUDY

YAMUNA BIODIVERSITY PARK, NEW DELHI

Prepared by the Students of B.Sc (H) Anthropology, III Year

Compiled and Edited by Rashi Agarwal

2015

DECLARATION

We, the Students of B.Sc. Anthropology (H), III Yr, do hereby solemnly declare that the subject matter in this Case Study is authentic and the work is done by us. We have genuinely worked to prepare this report after collecting empirical data from the research area.

This work has not been submitted to any other Institution for any other degree.

Class Representative

Rashi Agarwal

B.Sc. Anthropology (H)

III Yr.

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ACKNOWLEDGMENTS

In this time and age, no project comes to fruition without extensive collaboration of the colleagues. Beyond the shared endeavors of the classmates, this project owes its completion to a wide range of people, from teachers in the discipline to those involved in the production process.

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UNIT I
INTRODUCTION

Sarthak Malhotra

O Earth! Pleasant be thy hills, snow-clad mountains and forests; O numerous coloured, firm and protected Earth! On this earth I stand, undefeated, unslain, unhurt."

Atharva Veda (12.1.11)

"Whatever I dig out from you, O Earth! May that have quick regeneration again; may we not damage thy vital habitat and heart"

Atharva Veda (12.1.35)

Biodiversity Conversation for Heritage And Identity

The new environment paradigm in anthropological thought functions with a 'human non-expemtionalist' thought, that human beings are just one of the many species inhabiting the earth. This thought was most evident in the ecosystems approach prevalent in the ecological anthropology of the 1960s onwards. Principally, it focused on the fluid, dialogical and creative interactions between humans and their environment. The relationship between humans and non-human biological and non-biological life was studied with the aim of explaining cultural change.

As anthropology saw a shift from the more theoretical and biological considerations of studying ecosystems and ecology, an attempt was made to holistically study the impact of human life on the non-human aspects of the ecosystem. An ecosystem is a demarcated region of the biosphere with a regulated, processual interaction between species (and non-living components) between whom, "materials exchange and energy flows". Ecosystems are believed to be a in a homeostasis; the innumerable internal interactions are in a dynamic equilibrium.

Critics of human intervention, views of dominance and the objectification and exploitation of nature, have considered human intervention, as a destroyer of balance. Human activities, influenced by dominant culture-specific conceptions of nature, have shattered different delicate ecological balances. This 'dominant western worldview' has been criticized severely for its proclamation (both theoretical and, in practice) of human being's dominance and nature's subservience.

With the recognition of the interconnectedness of the earth, the global community made attempts to preserve lost ecological processes. This included the conservation of local biodiversity, through national parks (such as Yellowstone), and also the recognition of the rights of indigenous peoples (who had long been exploited and marginalized) and their systems of knowledge, that were cultural adaptations to the environment. Indigenous knowledge systems included the adaptive, experienced and holistic methods of interacting with, using and preserving nature. Such practices, often prefixed with the word 'ethno' (ethnoforestry, ethnobotany, ethnozoology and so on) appreciated, and attempts were made to understand their practicality.

The integration of indigenous knowledge and biodiversity conservation was influenced by global initiatives such as the Convention on Biological Diversity, the Earth Summits and so on. In India, it took the form of the Biodiversity Act, setting up of several national parks, sanctuaries, biosphere reserves, the National Biodiversity Authority, along with UNDP and local NGO programmes.

The conservation of biodiversity. This is a deceptively simple sentence. In its syntax, hides a complex, esoteric vocabulary of ecological and biological concepts, which is the stronghold of scientists. As an anthropocentric concept, with humans being the primary cause and the major resolvers, of the present day ecological crises, it is essential to look at the anthropological influences and consequences of such processes.

Biodiversity is the matter of ecology, its foundation; its conservation, therefore, is important in terms of securing the ecological essence of a place. Biodiversity plays a crucial and fundamental role in maintaining ecological balance, but it also has cultural, educational and conservation functions. If culture is seen as the "middle term", between "human activities and the physical environment" (Forde 1963:463 in Soeftestad 1989:9), then it is the interpretive and symbolic value of biodiversity which is of primary concern. In a Stewardian plane biodiversity forms part of the 'environmental core', a set of culturally-significant ecological factors which influence social life. This influence is in the form of a duality (an interpretation of Harris's mental and behavioral categories). Biodiversity has a life permitting and sustaining role; but it also has a cultural role, in that allows a community to make

sense of the world around them (in the form of a local, environmentally determined superstructure: religion, myths, games, art etc.). It forms an identity, a sense of belongingness to the local topography.

This is made clearer in the case of Punjab. The state has lost all of its indigenous biodiversity; the local species being replaced by exotic weeds and agricultural monocultures. This has resulted in a loss of bird and animal diversity too. Agricultural monocultures are at risk as fields no longer support a vibrant ecosystem that existed to safeguard crops from pest attacks. Certain plants were meant to act like natural pesticides and support insect and faunal communities that would reduce pests; not only this, but they would contribute to the naturally fertility mechanisms acting in the ecosystem. A loss of this has resulted in agriculture, which is at great risk of pest-damage. This has lead to a substantial increase in the use of chemical pesticides and fertilizers, the adverse human impact of which is well-known.

A person returning to the Punjab after many decades will no longer see the plants that they grew up with or hear the birds they heard in their childhood. This loss of natural heritage (monocultural agriculture needing to the loss of a once self-sustaining ecosystem) has also led to loss identity. This cultural-ecological loss has taken place slowly and without local realization.

The same is true of Bangalore where the once plentiful lakes that sustained its water systems are either "dead polluted or covered up" and used as real estate; 98% of the species in Bangalore city parks are exotic.

The direct relationship between human intervention and loss of biodiversity is clear in the example of Delhi. Yamuna's floodplain has been reduced from a natural width of ten kilometers to only 300 meters at certain places. The "luxuriant forests", grasslands, wetlands and wildlife that it once supported have been replaced by human settlements (occupied mostly by migrants to the city, who have no sense of association to the natural heritage of the city, and are thus, less inclined not to preserve it). This has led to the deterioration of the environment and loss of native species. The introduction of exotic trees, especially the *Vilayti keekar* (*Prosopis juliflora*) to the once barren ridge by the British, too wiped out over five hundred native species of Delhi. The ridge and the river serve as interdependent

systems; the former acts a barrier to hot waves from Rajasthan, dust storms and thus, has prevented the desertification of the Gangetic plains (the rampant reduction of the Aravali mountains, primarily due to mining has not only potential for destroying the local ecosystem, but can also lead to the advent of Thar sand to the fertile Ganga-Yamuna doab, which can ultimately reduce its fertility).

The aim of conservation is to create a "self-sustaining ecosystem", an area of interaction that generates ecological services. To do this, Yamuna Biodiversity Park and the Aravali Biodiversity Park (both under the Delhi Biodiversity Foundation), the natural heritage of the Yamuna floodplains and the Aravalis had to be studied and understood. For the Yamuna Biodiversity Park, surveys were conducted throughout its course from the Siwalik Hills to Allahabad. After recreating ecological conditions (valleys, ridges and so on) and developing biotic plant communities (mounds), the conservation process took shape. Eventually nature took its course and each plant group got its own animal group.

Biodiversity has conservation functions; trees "are the *only*" ways of ensuring environmental stability, reducing pollution, the concentration of PM 2.5, dust and so on. It also has educational value, and works as a tool for natural heritage based environmental education.

There are wider institutional concerns in biodiversity conservation. There exists a substantial, nation-wide mechanism for the integration of Universities, scientific organizations, R&D centers and conservation units, in addressing environmental issues (WGEEP, 2011). There is also a concern that "modern technologies" are not being used in solving environmental issues. This is a limited cause for concern given that in indigenous environmental information of biodiversity management and conservation is gaining institutional and public popularity. Despite this, in-situ conservation schemes lack the use of remote sensing and GIS technologies, use of mechanization in material handling and lack of effective biologically derived methods in pest and vector control.

The outreach programme adopted by the Yamuna Biodiversity Park is in line with a national need to incorporate school and university students to make contributions to environmentally and socially sound development (REPORT). This, however, needs to be incorporated into a larger curriculum of integrated environment and

heritage education that, ideally, should focus on a definite locality but be inspired by global standards. Environmental education is compulsory at all stages of the education process (from the primary level through university education) (Supreme Court Order of 22 November, 1991). The park is an ideal learning resource which provides practical lessons in not only understanding ecological processes, but also integrated conservation and management procedures. It is part of a wider need to ground environmental education in student activities relating to local environmental issues, and to use this information and experience to create nationwide youth participation and leadership in this domain.

This has applications in the domain of tourism. As a recreational centre, the Yamuna Biodiversity Park is an educational tourism centre situated within the Capital. Given its accessibility (it can be argued that it is not yet as accessible as it can be), this park forms part of a wider ecotourism network developing in the country. As currently practiced in India ecotourism has descended into mass tourism. Nevertheless, it is a form of tourism which promotes "environmentally responsible travel … to appreciate nature… that promotes conservation, has low negative visitor impact" (IUCN). At the Park, the practice of restricted and guided entry has prevented negative tourist impact to a considerable extent. Further, a network of visitors (including educational visitors) can be integrated at a wider platform on information sharing, to promote general public sympathy or interest in conservation.

UNIT II

ORIGINS

HISTORY AND JOURNEY OF BIODIVERSITY PARK

Chapter 1
State of the Place before the Biodiversity Park

Chonsing Shimrah

The reason for existence of Delhi is because of the Yamuna- Aravali ecosystem.

The prime goal of the park is conservation and preservation of ecosystems of the two major landforms of Delhi, the river Yamuna and the Aravali hills. They seek to conserve keystone species and other threatened plant and animal species, preserve the biodiversity of any habitat that is likely to be converted into urban infrastructure, establish field gene banks for threatened land races and wild genetic resources, promote education on environmental awareness and nature conservation, establish native communities of the Aravali hills and the River Yamuna basin particularly of the Delhi region, develop mosaic of wetlands that sustain the rich aquatic flora and fauna of the Yamuna and monitor short term and long term changes in the ecology of the Delhi region.

Thus, Yamuna Biodiversity Park act as heritage sites and repository of the approximately 50 threatened communities of the Yamuna river basin and Aravali hills. It provides ideal alternative habitats for migratory and resident bird species, enhance ground water recharge and augment fresh water availability, act as sinks for CO_2 and other pollutants, ameliorate local weather conditions and buffer ambient temperatures, promote eco-tourism and social connectivity across the urban community, serve as gene pools and represent unique ecological models possessing not only wildlife and natural values but also aesthetic, environmental and educational values.

Rapid industrialisation and human encroachments had left the Capital bereft of its natural glory. The development of this wilderness has set an example for not just States within our country but also countries across the globe that are now trying to emulate this nature reserve. “Recently we had a delegation of Canadian students to visit the park. Researchers from Britain and France have also come in the recent times to the park,” says Prof. C.R. Babu, Former Pro-Vice Chancellor and Environmental Studies Professor at Delhi University.

A team of scientists was assigned the task to bring back this vanishing flora and fauna. “These scientists surveyed all along the floodplains, upstream and downstream. They decided to bring back the plant species found along the river Yamuna and grow in the form of communities. This was a challenging task as 157 acres of land which was allotted to them, was located in Jagatpur village in the upstream of Wazirabad reservoir. This area used to be an active floodplain but now a bund was created consequent to which no vegetation was possible in the area and only salt loving plants like *Sueada Fruiticosa* could grow. However, now there are over 1,200 species of plants.” says Prof. C.R. Babu. He continues and says, “The transformation took place as the scientist first grew grasses known as *Leptochoal Fusca* and few other grasses which changed the pH of soil from 10 to 7. Once the soil became neutral they added farmyard manure like cow dung. Thereafter they planted samplings of various plant species.”

The scientists said that the Yamuna Biodiversity Park has about 1,000 species of flowering plants which used to exist in the flood plains several decades ago. These species have been thriving in the form of 20-25 plant communities now. It also has dry deciduous forests, tropical thorn forests, scrub jungles and the most

biologically rich grasslands. “The Yamuna Biodiversity Park is based on the ecosystem model. It is a 10-year-old plantation. The ecosystem is fully developed. All the faunal elements have come on their own,” said Dr Ekta Khurana, ecologist at the park.

“A huge wetland has already been created and more wetlands and marshes will soon be developed. Sixty per cent of the area will be under wetland marshes. Forty per cent of the area will be flood plains, forest and grasslands that can sustain the annual flood events. These wetlands will impound the floodwater and will serve as a habitat for many resident as well as migratory birds in the future,” said Dr. Mohammed Faisal, Scientist at the Yamuna Biodiversity Park.

Another scientist Dr. A.K. Singh, a Plant Taxonomist at the park said, “The entire project will take nearly six years to get completed .The project is lagging because of local issues like demarcation of land.”

In the first phase, nearly 100 acres of wetland would be created which will hold 500 million gallons of floodwater. This, according to environmentalist, will recharge the groundwater that will ultimately benefit people living along the alluvium plains of Delhi.

The Biodiversity Park, which represents Delhi’s natural heritage and rich biological diversity of the flood plains of Yamuna River, has also become a means of promoting natural education among school and college students.

As many as 40,000 students and public from all across the world visit the park annually. This park is however open to public only if they come in groups and are accompanied by a guide. This has been done in order to prevent the jungle from further pollution.

Yamuna Biodiversity Park in north Delhi was a pilot project in that direction. The work started in 2005 on a barren land which had solid soil and development of any kind of vegetation was difficult. Today, the area of 157 acres acts as a perfect example of successful restoration of the ecosystem by Professor Babu and his team.

Wetlands

“The wasteland was an inactive floodplain of Yamuna River when they started

working on it. The soil was not suitable for plantation. They developed two wetlands and grassland and forest communities on the rest of the land. The plantation was done in such a way that the salt content reduced. They planted the native species of Yamuna such as *Adina* community, *Sal* associate dominated, *Teek* associate*, Hardwickia*, etc. Today the wetlands attract thousands of migratory birds from Siberia, Central Asia and Europe," said Dr Mohammed Faisal, who manages the park.

Today, it has 75 species of butterflies, 200 species of birds, 10 species of snakes, 900 species of plants, and big mammals like porcupine, civets, and wild boars. The phase two of the park is 300 acres of active floodplain and is in the development stage.

Work is currently going on in Northern Ridge or the Kamla Nehru Ridge and at Neela Hauz near Jawahar Lal Nehru University.

Native species

While the development of Neela Hauz Biodiversity Park will be completed in another three-four months, scientists at Kamla Nehru Ridge have started pruning the canopies of *Prosopis juliflora* or '*Vilayti Keekar'*, a Mexican-native species which has encroached upon more than 90 per cent of the ridge area and eliminated the native species.

"*Vilayati Keekar* was planted by the British to beautify the wastelands. It contains toxic chemicals and is a massive biological invasion by any alien species. It finished all native species including khejari, tree of life. *Vilayati keekar* is not a good fodder, neither a good wood. It also depletes the groundwater," said Professor Babu. "We had to eradicate it and bring out the native vegetation in a phased manner through canopy opening technique. This plant prevents sunlight so we removed small branches so that sunlight can reach the native saplings planted by us," he added.

"The plan is to develop it into a wild forest and not like well-manicured parks. In other countries, there is a concept of city forests. But in India we have parks. There are so many parks in Delhi for recreation but nowhere will you find the kind of species and vegetation like we have in forests," said Dr A.K. Singh, who was earlier working to maintain the Yamuna Biodiversity Park site and now has started

developing the Kamla Nehru Ridge two months ago.

Similarly, Tilpat Valley, bordering the Asola Bhatti Wildlife Sanctuary, has also been encroached by '*Vilayti Keekar'*. "The work began on August 30, by plantation of about one lakh saplings. Tilpat Valley is also one of the deepest parts of Delhi. It can act as a water recharge zone for south Delhi," said Professor Babu.

Chapter 2

The Brain behind the Project: Prof. C. R. Babu

Drishta Gopala

The Yamuna Biodiversity Park, the first of its kind in Asia, if not the world, is the brain child of Prof. C.R. Babu, Professor Emeritus & Ex-Pro-Vice-Chancellor of the University of Delhi. Prof. Babu actively taught in the University of Delhi for 35 years. His work hours would average out to 22 hours per week with an added 8 hours for holding extra classes on weekends. Apart from this, he has also used his expertise in many field environmental restoration projects. The Biodiversity Parks are only one of his many successful projects.

Prof. Babu believes that land degradation is one of the biggest challenges of the 21st century. 43% of the world's vegetated land has lost its productivity potential, 50% of India's land is degraded.

Every year 1000s of acres of forest land is made into unproductive barren land due to open cast mining. These degraded lands must be restored to their original ecosystem to be able to have any form of sustainable development on the planet.

To restore degraded lands, the Forest department has resorted to implementing the Reclamation technique where foreign species are introduced to the degraded region and promote to create a new ecosystem. For instance, they introduced two Australian species: *Acaciaauri culiformis* and *Cassiasiamea*. These change the soil microbial communities and invertebrates, do not form part of any other local species diet, and cannot even be used as firewood due to its low calorific value.

The other commonly used approach is Ecological Rehabilitation which involves restoring the ecosystem to a certain extent by introducing few plant species. But this approach too doesn't aim to restore it to its original state. The objective to bring back original ecological state is to sustain the ecological services and goods

that it was rendering to the region, which is not accomplished in this partial rehabilitation.

The new discipline introduced here is called Ecological Restoration which works towards restoring a dead ecosystem to its original state which will provide all the ecological services and goods that it did originally, before degradation.

What is Ecological Restoration?

Ecological Restoration is a form of Ecological Engineering which involves assembling of ecological communities that provide bio-physical processes which lead to ecosystem rehabilitation.

Assembling of ecological communities requires the collection and grouping of all the species of the original ecosystem into several sub-ecological assemblages based upon their niche requirements. These are now reintroduced into the degraded landscape in successive stages where they eventually establish themselves and flourish once again into an ecosystem of the same level as it existed before degradation.

Concept of a Biodiversity Park

Based upon the Ecological Restoration principle, the team headed by Prof. Babu, for the first time, developed the concept of a Biodiversity Park. Such a park aims to conserve the natural heritage in urban centers and also to enhance the quality of the environment. The first step in setting up any such park is the identification and assembling of the native species characteristic to that area, to reintroduce, recreate and maintain them over the limited degraded landscape. Essentially, the biodiversity parks are limited stretches of marginalized landscapes of wilderness where assemblages of ecological communities of native species are recreated and maintained. The underlying principle of biodiversity parks is to create self-sustaining ecosystems that serve as nature reserves of the area.

A biodiversity Park serves three most important functions besides enhancing the quality of the urban environment:

1. Educational
2. Cultural
3. Conservational

The manifestation of the above functions can take the form of the following among others:

- It helps to connect the natural biodiversity to the city and its people who have lost contact with it
- It provides new livelihoods to the local people
- Preserves rare, endemic and threatened species
- Serves as a living lab to study the processes and functions of a functioning ecosystem
- Buffers the local weather
- Serves as a sink for CO_2 and urban air pollutants.

A biodiversity park is only successful if it can attain complete self-sustenance. This is possible only when there is a large enough area to develop an ecosystem since a small area can support lesser variability of species. Therefore, it is of the utmost importance for such a project, to carefully locate a large enough and suitable area on which to begin the project of introducing ecological assemblages.

The land in and around New Delhi is very expensive and such a major project could not have been undertaken independently without any governmental support. Prof. Babu is very appreciative of the Delhi Developmental Authority to have fulfilled this supportive role through allocation of land and grants. (Babu, 2015)

Conception of the Project

Once organizing a workshop, Prof. Babu invited the then Lieutenant Governor of Delhi, Vijay Kapoor. During the course of the workshop he shared his concern of the lost native species of Delhi and the need to preserve them, with Mr. Kapoor. When Mr. Kapoor asked Prof. Babu to recommend a solution, he suggested the need for a Biodiversity Park. The very next day, the Lt. Governor declared 150 acres to be developed into the Biodiversity Park. In 15 days, the Delhi Development Authority (DDA) acquired the requisite land and proposal for the project was submitted. Mr. Kapoor then handed over the responsibility of developing the land into a biodiversity park to Prof. Babu. Delhi Development Authority is a land owning and city building local government agency, which along with the collaboration with Centre for Environmental Management of Degraded Ecosystems helped make the project a reality by funding and notifying six regions as Biodiversity Parks:

1. Yamuna,
2. Aravali,
3. Neela Hauz,
4. Kamla Nehru Ridge,
5. Tilpat Valley,
6. Yamuna River Front

These include a large area spanning across a 52 km stretch and approx.4000 hectares, which the National Green Tribunal has designated to be converted into biodiversity parks and wetlands.

Biodiversity Park

A typical Biodiversity Park should have two basic components: A **Nature Conservation Zone** for Terrestrial communities including a mosaic of grasslands and wetlands; and a **Visitor Zone** which can have many components such as a Herbal Garden, Butterfly Conservatory, a Scared Grove, a Climbers' Grove, Recreational Garden with walkways and a representative of the ecosystems.

The Biodiversity Parks strive to become a part of the urban infrastructure.

The success of the two Biodiversity Parks that have been established already can be gauged by comparing the number of species at 2,500 which are assembled into 25-30 biological communities in both the parks today as compared to the original number at just 25-30 species of fauna.

The criteria for judging that an ecosystem has been restored are to check if it is generating Ecological Services and Goods. These include moisture retention in the soil, increase in humidity and rainfall, reduction in dust pollution, reappearance of economic species of plants and animals, etc.

Challenges to Sustainable Development

The biggest challenge in degraded land restoration and sustainable development, according to Prof. Babu, is the indifference of the Government toward the Sciences. The political community does not consult the scientists when formulating policies and taking decisions regarding planning and development. Political concerns tend to take precedence over scientific sensibilities in these domains. Scientists are only consulted in times of Natural Disasters and epidemics to find solutions to these.

However he says, that slowly the Government is beginning to realise this problem as the Committee of Indian Bureau of Standards for preparing guidelines for Smart Cities now has a good number of scientists, including Prof. Babu himself, as compared to earlier when it was dominated purely by Civil Engineers. Civil Engineers do not understand the relevance of **Natural Resources Sustainability** and **Environmental Sustainability** which are essential to maintain the **Quality of Life** which is the purpose of a Smart City. (Babu, setting up of biodiversity parks and restoration of mined out areas)

For this reason, the government is now increasingly engaging scientists that specialise in these very fields to aid in the planning and development of Smart cities and hopefully this will lead to a better direction of development in our country.

Chapter 3

Proposal and Involvement

Ngawang Tselha

Definition of Biodiversity Park

It is a unique landscape of wilderness where the ecological native species are assembled together in the form of biological communities which are recreated and maintained over a degraded or marginal land.

Why there is a need of such Biodiversity Park in India?

With the ever developing world, it gives no break in the goal of urbanisation which leads into expanding of already urbanised places and also emergence of new urban centres. India can be taken as an example of such places in the world. This process ultimately wiped and is still on process of wiping out the whole native species such as that of Delhi's forest and flood plains of Yamuna. So as to mitigate further loss of native species and to revive the lost and to improve the quality of environment in urban matrix, there is high need of creation of such Biodiversity parks in India.

The plan of building the Yamuna Biodiversity Park came up in the year 2002 and since then the work is going on in this project with a proposal of bettering the green cover in Delhi.

Proposal:

Goals of Yamuna Biodiversity Park-

- Conservation of Keystone species and other plant and animal species that are threatened.

- Preservation of the biodiversity of any habitat that is likely to be converted into urban infrastructure.
- Establishment of field gene banks for threatened land areas and wild genetic resources.
- Promotion of education on environmental awareness and nature conservation.
- Establishment of native's communities of river Yamuna basin particularly of Delhi region.
- Development of a mosaic of wetlands that sustain a rich aquatic flora and fauna of Yamuna.
- Monitoring of short term and long term changes in ecology of Delhi region through research.

People involved in the Yamuna Biodiversity Park:

The Biodiversity Park Concept was implemented for the first time in Delhi by Delhi Development Authority (DDA) – a land-owning and city building local government agency in collaboration with the Centre for Environmental Management of Degraded Ecosystems (CEMDE) of the University of Delhi, under the aegis of Delhi Biodiversity Foundation with Hon'ble Lt. Governor.

Presently University of Delhi is implementing two DDA funded Biodiversity Park Projects namely **Yamuna Biodiversity Park**: Establishment & Management; and **Aravali Biodiversity Park**: Establishment & Management with Prof. C. R. Babu as Project-in-charge and Faisal Khudzar as the scientist and in charge of the Yamuna Biodiversity Park.

For a better preservation of nature and to retain the ecological, aesthetical and cultural quality of Biodiversity sites in the National Capital Territory of Delhi, the DDA has set up the Delhi Biodiversity Foundation. Technical inputs include teams of scientists who have specialized in the areas of field biology, ecology, wildlife, taxonomy, conservation, habitat restoration, natural resource management and nature education. In addition to these experts , there are trained technical supporting staff who look after the development and management of these parks. The Foundation consists of two groups; Governing body and Executive committee.

In University, these projects are administered as per the "Guidelines for sponsored research projects" approved by the Executive Council.

The present members of the Governing Body are:

Hon'ble Lt. Governor, Delhi	**Chairman**
Vice-Chairman, DDA	Vice-Chairman
Chief-Secretary, GNCT of Delhi	Member
Vice- Chancellor, Delhi Univeristy or his Nominee	Member
Engineer Member, DDA	Member
Finance Member, DDA	Member
Joint Secretary, Min. of Urban Development GOI	Member
Director CEMDE	Member
Commissioner(planning), DDA	Member
Secretary (Environment and Forest) GNCT of Delhi	Member
Project Incharge Biodiversity Parks, Univeristy of Delhi	Special Invitee
Director (Landscape) , DDA	Member Secy.

Co-opted Members:

In addition to the foundation there are Co-opt members from eminent Scientists, Botanists, Zoologists, Landscape Architects, Environmental

planners, Experts from IARI and other NGOs/ institutions and renowned citizen.

Present Members of Executive Committee:

Vice-chairman, DDA	**Chairman**
Engineer Member, DDA	Member
Finance Member, DDA	Member
Director CEMDE	Member
Project in charge, Biodiversity Parks	Member

Table 1: The amount released and expenditure for the Yamuna Biodiversity Park upto 31.03.2011 are given below:

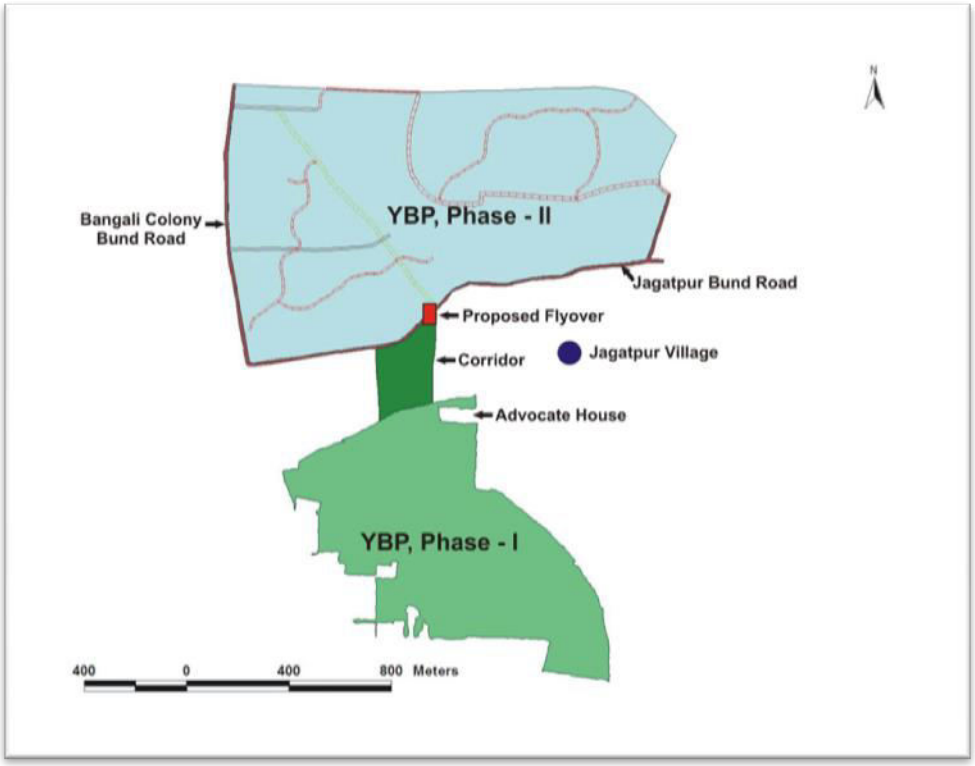
Year	Amount released	Expenditure
2003-2004	59,91,389/-	* 52,07,297/-
2004-2005	79,18,440/-	73,08,835/-
2005-2006	72,53,500/-	62,99,047/-
2006-2007	91,05,541/-	70,85,812/-
2007-2008	81,76,871/-	95,45,298/-
2008-2009	82,20,712/-	90,97,759/-
2009-2010	80,00,000/-	81,32,819/-
2010-2011	80,66,304/-	92,31,806/-
Total (A)	6,27,32,757/-	6,19,08,673/-

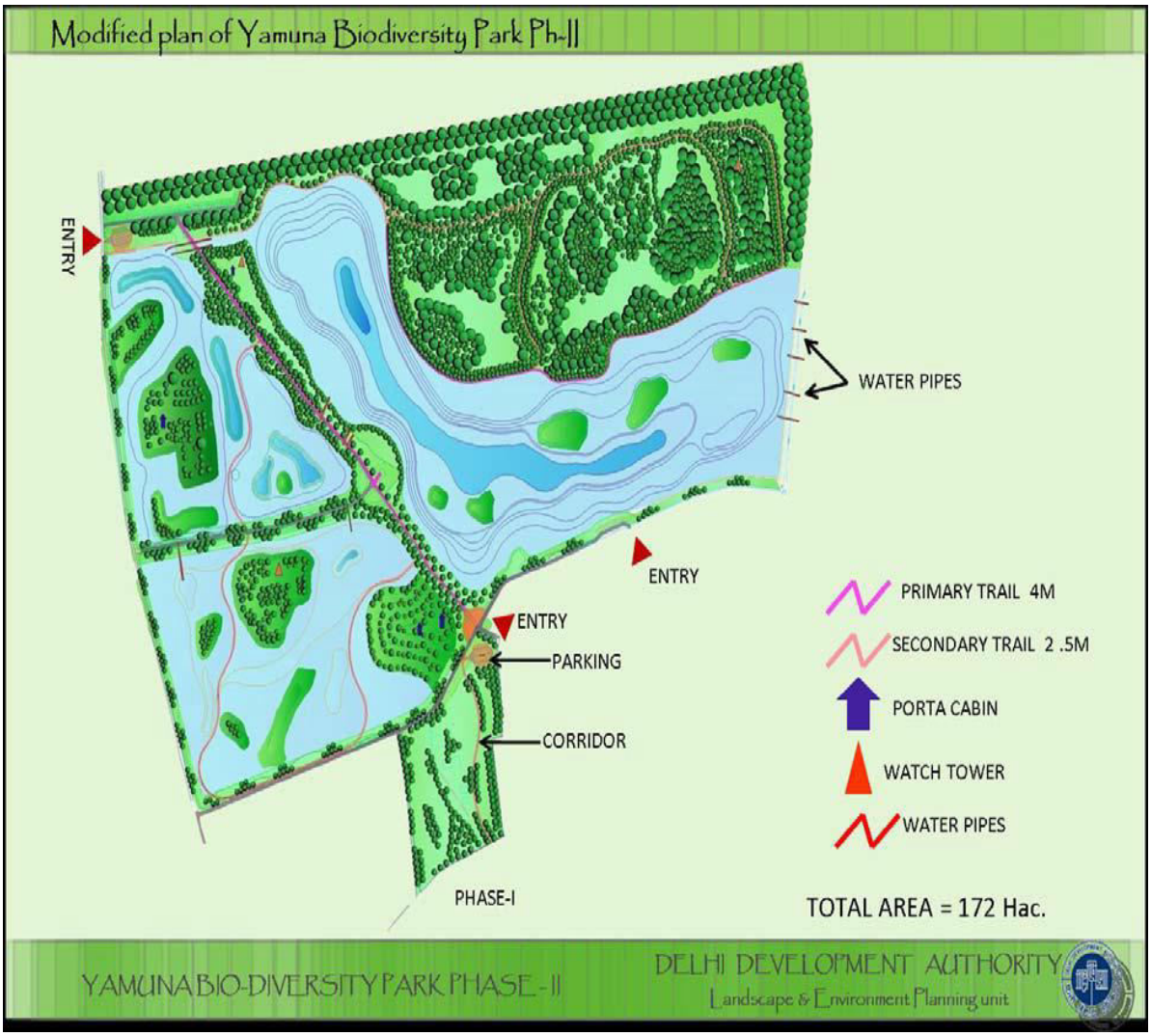
*including the initial grant of Rs. 5,90,000/- during 2001-2002

Table 2: The amount released and expenditure for the Yamuna Biodiversity Park Phase II upto 31.03.2011 are given below:

Year Amount	Released	Expenditure
2009-2010	37,57,392/-	Nil
2010-2011	--	4,21,254/-
Total	**37,57,392/-**	**4,21,254/-**

Layout of Yamuna Biodiversity Park:




Modified plan of Yamuna Biodiversity Park Ph-II
ENTRY
WATER PIPES
ENTRY
ENTRY
PARKING
CORRIDOR
PHASE-I
PRIMARY TRAIL 4M
SECONDARY TRAIL 2 .5M
PORTA CABIN
WATCH TOWER
WATER PIPES
TOTAL AREA = 172 Hac.
YAMUNA BIO-DIVERSITY PARK PHASE - II
DELHI DEVELOPMENT AUTHORITY
Landscape & Environment Planning unit

Chapter 4

People and Politics

Srividya Venkat

The **Yamuna Biodiversity Park** is presently spread over an area of approximately 457 acres in the Jagatpur village, Wazirabad, on the flat alluvial plains of the Yamuna. The project was proposed by the Delhi government for saving the dying Yamuna River in Delhi. When the project was underatken by DDA, the then Deputy Prime Minister, L.K. Advani said, "...by taking up such environmental upgradation projects, DDA has shown that it not only constructs houses but is also developing the city in an integrated manner..."

On the other hand, it was Prof. C.R. Babu, who with his own experience and expertise began collecting like-minded people from different fields, formed out a team and started a scientific perception of setting up an ecological biodiversity in the pollution capital of India.

The area given by the DDA for constructing the biodiversity park was initially an agricultural land on the Yamuna Khaddar area, where the wetlands exist today. Scores of farmers from across the Yamuna floodplains protested against DDA's plan to create a biodiversity park in the Yamuna Khaddar area. They were joined by water activists Rajendra Singh and Manoj Misra. While the Delhi Peasants Cooperative called it a "maha-panchayat," who mainly protested against the loss of livelihood and displacement of farmers from the region. Yamuna Khaddar supplies fresh vegetables to the city and livelihood of several people depends on it. "Our farms also help in groundwater recharge" said Baljeet Singh, head of the co-operative. But it was found that the farmers used extensive pesticides and fertilizers eventually adding up to the already polluted Yamuna. Gradually, the case was won by the DDA and the land was given for the park's construction.

Justice B.D. Ahmed and Justice Sanjeev Sachdeva, the honourable jury for the case said that chemical agriculture was not helping in the city's development but worsening it and the construction of the park and recreating the biological diversity is necessary for Delhi to live.

Apart from the salinity of the soil, another problem emerged during the extension of the park to phase-II area, an area of around 87 acres allotted recently. The land allotted for the park belonged to a Gujjar community in Jagatpur village and the people were to be relocated. The relocation work was done by the DDA and the Delhi Government, but the problem was their livelihood source which was farming and had been lost with the loss of their lands. This was solved when Dr. Faisal Khudsar, scientist at the park, proposed to employ people in their park as plantation workers.

Chapter 5

Yamuna Biodiversity Park and Yellowstone National Park: A Comparative Study

Keisham Keshwarjit

Yellowstone National Park was the first national park in the world established in United States in 1872. This park is protecting different species of flora and fauna in their natural environment. Other non-native and exotic species are also protected in this area. The vast natural forest of this park covers nearly 9000 sq km. It contains half of all world geothermal features and it has the world largest concentration of geysers.

It is a UNESCO listed heritage sites for the large numbers of rare plant and animal species that are found within the park. The park hosts nearly 4 million visitors every year. Most of these visits happen between the month of May and September but people do also visit to the park year-round. The park is the home to a large variety of mammals, birds, fish, reptiles and amphibians which are a major attraction of people.

Again various wetlands occupy over 357 sq miles (924sq km). Of the park: 44% are lakes and ponds, 4% are rivers and streams and 52 % are shallow water system that dries up most years. Approximately 38% of parks plant species including half of the rare plant species are associated with wetlands and 11% grows only in wetlands. Wetlands provide

essential habitat for Yellowstone's rare plants, thermal species, reptiles, amphibians and other numerous insects' birds and fishes.

UNIT III
MODULES AND DEPARTMENTS

Ashwin Tripathi,

Srishti Bhatnagar,

Garima Bisht,

Wairopam Amarjeet

Om Anirudh

The Park Features Two Major Zones - The Visitor Zone and the Nature Reserve Zone.

Domesticated Biodiversity Zone

The front portion of the Yamuna Biodiversity Park, a 220m southward and 140m northward stretch from the main entry gate with 20-30m width is demarcated as Domesticated Biodiversity Zone. Enclosed by a hedge of poplar, it features plants like *Ailanthus, Butea* and *Bauhinia* that have a continuous seasonal interest due to their long flower production throughout the season. The outer iron fencing is embraced by multi-colored climbers like *Jasmine* and *Quisqualis* with the same theme of continual luxury.

Resting Point

Located at the main entrance, at the southward end, are three snack bars, a drinking water facilities and three resting places covered with the vines of *Argyreia nervosa, Jasminum sambac* and *Petrogea volubilis*. Just past the entry pocket and to the right is a "Welcome Rock Facet" representing the origin of the Ganga and Yamuna and their convergence at Allahabad. A trail further leads to the **Bambusetum, the Nature interpretation Centre, the Conservatory of fruit yielding species, the Migratory duck's wetland** and **the Nature Reserve area**.

A View of Nature Interpretation Centre

Nature interpretation Centre is a beautiful classical building with elegant lighting, a red carpet floor, attractive interior designs, panels depicting various biodiversity levels, touch screens, and visual-aids that provide an insight into the basic concepts of biodiversity.

On the left, the landscaping provides two shallow valleys representing Rangelands

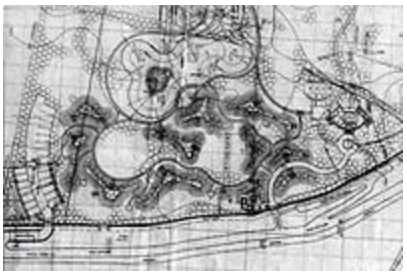
Welcome Rock Facet

The first Rangeland i.e. Rangeland 1, corresponds to an exclusive *Sporobolus diander* dominance while the second one i.e. Rangeland 2 showcases a mixture of native tropical grasses such as *Dichanthium, Chrysopogon, Vetiveria,* and *Bothriochloa*. These two rangelands are bordered by a *Serpentine* trail. The first loop of the trail connects Rangeland 1 with **Herbal garden, Sacred Grove** and Rangeland 2 while the other loop leads to the **Butterfly Conservatory** and Amphitheatre.

Visitor Area Trail

The Amphitheatre is an open auditorium whereas the Herbal Garden offers a collection of about 450 plant species with healing properties.

On this loop trail, one sometimes come across bouncing hares and has a chance to watch *Red-Wattle Lap Wings* and other grassland birds. The exit of the Butterfly Conservatory on the west side leads to Sacred Grove and the Gene Bank of Petro- and Oil-yielding and other plants through the Bamboo Bridge from which one can enjoy a view of the resident ducks' wetland and a wide variety of fishes.



Mounds

Surrounding the valley, are the **Ten Mounds** which represent different ecosystems from the foothills of the Himalayas (Siwaliks) through the Yamuna basin, till the point of confluence of the Yamuna and Ganga and illustrate different forest ecosystems in its miniature form found all along the Yamuna River Basin. The composition of forests, as in nature, consists of three to four layers: a Tree Canopy that supports climbers and provides shade for the Middle Storey tree layer and Shrub Layer which in turn protect the ground-cover of herbs and grasses. Plantation on these mounds is designed on the basis of the structure and composition of the forest ecosystem found in its natural environment.

MODULES

The whole park is divided into different modules like Adina-Mitragyna dominated, Teak dominated moist deciduous, Sal and accociates, Teak Dominated Dry Decidious, Acacia Woodlands, Grasslands, Scrub Jungle, Butterfly Conservatory, Wetland Communities, Semi-Evergreen Low Ying Forests etc. Each module is dependent on the other module for its survival (butterfly and pollination). The recreated nature reserve is now home for 2000 plant and animal species living in some 30 biotic communities.

The major components of Yamuna Biodiversity Park Phase1 are Conservatories of Medicinal plants, Butterflies and fruit plants, besides Rangelands, Scared groves, Migratory ducks' wetland and Resident duck's wetland. Around 30 forest

communities of Yamuna River Basin are recreated in the park, having diverse ecological niches that not only attract a wide range of animal species but also enable them to build viable populations. The wetlands created in the park attract thousands of migratory ducks from Siberia, Central Asia, Europe and China in winters besides many resident birds.

PHASE 1

- **WETLANDS AND BIRDS OF YAMUNA BIODIVERSITY PARK:** The ecological diversity within the wetland habitat sustains rich flora and fauna. The high primary productivity contributed by abundant phyto and zooplanktons and submerged, floating and emergent aquatic vegetation attracts a wide range of birds and other benthic fauna and fishes
- **RANGELANDS:** It is dominated by mainly the herbaceous plants. Eg. *Kush, Khas, Zarga* etc. Insects like *Beetles* and *Grasshoppers* are also prevalent.
- **CONSERVATORY OF MEDICINAL PLANTS:** A large number of species of herbal plants are maintained over here. For eg, *Brahmi, Safed Museli, Damabel*, etc which are used to cure ailments.
- **CLIMBER GROVE:** Climbers such as *Lianas* (woody climbers), and sub-woody and herbaceous climbers are also present. Some of them reach to the top of the forest canopy using trees as support to get sunlight, which is a limiting factor for species found in forest. There are a number of varieties of climbers that are found here like *Mahul*(used for making plates), *Genthi* (yields edible tubers and bulbs), *Dama-Bel* (used for asthama treatment)
- **FOREST COMMUNITIES:** About 850 plant species were ecologically assembled into 30 different forest communities which include *Teak*, *Mitragyna, Adina*, *Dalbergia*, *Emblica* and *Hardwickia*.
- **CONSERVATORY OF FRUIT PLANTS:** Dominant here are the fruit yielding trees or shrubs. The park has several varieties of fruits like *Promegranate* and *Guava* etc.
- **BUTTERFLY CONSERVATORY AND TERRESTRIAL BIRDS:** The park is home for a number of species of butterflies including *Common castor, Peacock pansy*, and insects like species of *Moths, Flies, Aphids* etc.

PHASE 2

In 2009, another part, phase 2 was formed which is a 'flood-active' region and connected to the phase1 by a corridor. Today, about a thousand different biological communities are coexisting at YBD, with about 250 bird species, including the migratory birds.

Phase 2 is not open for public. It is well protected and the diversity is self sustainable. This part of the park consists of a mosaic of wetlands together with the grasslands and floodplains forest communities. The floodplains forests together with wetlands provide:

1) Flood relief in downstream
2) Prevention of siltation in reservoir
3) Water purification
4) Enhancement of ground water recharge
5) Enhance base flow into the river during lean season

These wetlands also provide ideal habitat for the rich aquatic communities including 70 species

DEPARTMENTS

Yamuna Biodiversity Park has many departments and posts. But, due to extreme interdependence, the role of one is not confined to any one primary role. Along with it, people perform a whole lot of other tasks. Few of the many specialists that work under Yamuna Biodiversity Park are the Taxonomists, Ecologists, Scientists, Birds Experts, Environmentalists, Zoologists, Botanists, Conservationists, Soil Scientists, Technicians etc.

They take care of the minutest happenings in the park and observe and record it. The problems that the park faced are worked upon by all the people.

Apart from these, there are a number of Multitaskers involved in the park who have been allotted the tasks of digging, cutting, watering, etc.

UNIT IV
SCIENCE AND ECOSYSTEM

Chapter 1

A Brief Outline

Rashi Agarwal

According to the environmentalists and scientists, the species of plants which have been restored are collected from jungles in the adjoining States — including Haryana, Madhya Pradesh and Uttarakhand — and revived in Delhi by creating favourable conditions. The medicinal and fruit plants such as *Tylophora asthemetica, Ceropegie bulbosa, Gala, Khirnis*, White variety of Jamun, which were once found in abundance in the Yamuna basin forests, have been reintroduced for conservation.

The Biodiversity Park, is also providing a home to a variegated hue of birds and species of animals. The environmentalists have also created a wetland in the park that harbours 60 species of fish including *Katla* and *Rohu*. Experts at Yamuna Biodiversity Park said that along with the vegetation also came a large population of mongoose *Indian Hare, Porcupine* and most interestingly Wild Pigs. It also has a Butterfly Conservatory which contains 55 different species of butterflies. At the beginning there were just 35 species of birds but today there are 200 species. It also has a conservatory of about 450 species of fruit yielding trees. Its herbal conservatory boasts of at least 350 medical plants.

20 different biotic communities are being created in the approximately 130 acres of the nature reserve zone. The communities are developed by massive plantation programmes, some have already developed canopies and have attracted animals such as the *Monitor lizard, Civet, Jungle Cat* and *Nilgai*, which were never found before here.

Chapter 2

Flora

Singmichon Keishing

Yamuna Biodiversity Park has been able to grow a wide variety of plants, shrubs, trees, herbs, etc. under different modules according to their competition and symbiotic relationship. Hence, one can see the different ecosystems springing up naturally.

These ecosystems are:

Subtropical Mixed Evergreen Forest Ecosystem
Top Canopy – *Toona ciliata, Dalbergia latifolia, Mitragyna parvifolia, Syzygium cumini*
Middle Storey – *Trewia nudiflora, Artocarpus lakoocha, Cinnamomum camphora,*
Shrub Layer- *Dillenia indica, Coffea benghalensis, Murraya paniculata, Bauhinia malabarica,*
Herbs and Grasses- *Barleria cristata, Flemingia bracteata, Desmodium triflorum*
Climbers- *Vigna capensis, Combretum decandrum, Vitis paniculatum*

Moist Tropical Deciduous Forest Ecosystem with Teak as a Dominant Species
Top Canopy- *Tectona grandis, Pterocarpus marsupium, Diospyros melanoxylon,*
Middle Storey- *Buchanania lanzan, Albizia lebbeck, Bauhinia variegata*
Shrub Layer- *Flemingia rugosus, Vitex negundo, Nyctanthus arbortristris, Zizyphus mauritiana*
Herbs And Grasses- *Desmodium triflorum, Crotolaria juncea, Bothriochloa pertusa,*
Climbers- *Pueraria phaseoloides, Asparagus racemosus*

Tropical Dry Deciduous Forest Ecosystem with Sal as a Dominant Species
Top Canopy – *Shorea robusta, Diosprosme lanoxylon, Putranjiva roxburghii,*
Middle Storey – *Erythrina indica, Cassia fistula, Albizia sp., Sterculia urens*

Shrub Layer – *Carissa spinarum, Zizyphus oenoplea, Nyctanthus arbortristris*
Herbs & Grasses – *Chloris, Eragrostis, Fimbristylis ferruginea, Indigofera tinctoria,*
Climbers – *Smilax zeylanica, , Clittoria turnatea, Marsidenia, Cocculus hirsutus*

Tropical Dry Deciduous Forest with Teak as a Dominant Species
Top Canopy – *Tectona grandis, Buteamono sperma, Sterculia urens, Termina liachebula,*
Middle Storey – *Emblica officinalis, Bauhina variegata, Cochlospermum religiosum*
Shrub Layer – *Gardenia turgida, Randia dumetorum, Grewia asiatica*
Herbs & Grasses – *Barleria prionitis, Bothriochloa pertusa, Dicanthium hetropogo*
Climbers – *Abrus pulchellus, Cocculus hirsutus*

Tropical Thorn Forest
Top Canopy- *Acacia sp., Prosopis cineraria, Anogeissus pendula*
Underwoods- *Zizyphus mauritiana, Maytenus emarginatus, Wrightia*
Herbs and Grasses- *Vicovestata, Vico auriculata, Desmostachya bipinnata,*
Climbers- *Valletia, Leptochloa fusca, Tinospora cordifolia*

Scrub Jungle
Top Canopy- *Acacia catechu, A. senegal, A. leucophloea*
Underwoods- *Euphorbia neriifolia, Cassia auriculata, Maetenus emarginatus*
Herbs- *Tephrosia purpurea, Justicia simplex, Cyperus rotundus, Eragrostis tenella*
Climbers – *Cocculus laurifolius, Rhynchosia minima*

The major species found in the grasslands of Yamuna Biodiversity Park are Kush *(Desmostachya bipinnata),*Khas*(Vetivera zizanioides)*,Zarga *(Dichanthium annulatum)*,Dhawalu*(Chrysopogon fulvus)* ,Kallar *(Leptochloa fusca),* Khuighas*(Sporobolus diander),*Lalghas*(Bothriochloa pertusa*), Bansi*(Panicum antidolate)* and others. Herbal drugs are known to cure 'incurable' disease and have been used in traditional systems of medicine including Ayurveda, Unani, Siddha and Homeopathy. Ethnobotanical (traditional) knowledge, infact, forms the basis of many modern drugs.

About 350 species of the most well-known herbal plants are maintained in the conservatory. The most noteworthy among them are Brahmi (used to boost memory), Safed Musali (used as a tonic), Dama-bel(used as an asthma cure), 06 varieties of Tulsi, 04 varieties of lemon grass, 03 species of phyllanthus, isabgol and several species used to cure multiple aliments.

One of the characteristic of tropical forests is the presence of climbers such as lianas (woody climbers), and sub-woody and herbaceous climbers. Some of these climbers reach to the top of the forest canopy with support of trees to get sun light which is limiting factor for species found in forest. There are more than 20 species of climbers in Yamuna Biodiversity Park. The noteworthy climbers are Mahul *(Bauhinia vahlii)*, the leaves of which are used for making plates; Genthi *(Dioscoria bulbifera),* which yield edible tubers and bulbs; Dama-bel *(Tylophora indica),* leaves of which are used in the treatment of diabetes; Ghao bel *(Argyreia nervosa),* which is used in healing wound; and Giloi *(Tinospora cordifolia),* which is used as liver tonic.

About 850 plant species were ecologically assembled into 30 different forest communities. These communities include riparian, tropical dry deciduous, tropical thorn, shrub forest communities, and salt bush land. The riparian community that fringes along wetlands is represented that *Acacia nilotica- Tamarix aphylia* associated with common species such as *Sacccharum, Phragmitis, Vetiveria* and *Salvadora.* The riparian community has become home for herons and other wetland bird species.

The tropical dry deciduous communities are represented by *Adina, Mitagyna*, Teak, *Dalbergia, Emblica* and *Hardwickias* dominated communities; the tropical thorn and scrub communities are represented by *Prosopis cinerania*, *Grewia asiatica, Commiphora wightii*, and *Capparis sp.* Bamboo thicket is predominantly composed of *Dendrocalamus strictus, Bambusa bambus, Bambusa ventricosa* and *Bambusa nana*.

Historically, human settlements along the river Yamuna banks have been cultivating several tropical and sub-tropical fruit yielding trees/shrubs. Many of these cultivars (land races) are wild genetic resources and contain useful genes which can be used in the development and improvement of modern cultivars in terms of growth rate, pulp and fiber content and resistance to insects and pests. Yamuna Biodiversity Park has 7 varieties of Citrus fruit, 8 varieties of Anar, 06 varieties of sapota, 6 varieties of guava. Other fruit yielding species include Ber, Phalsa and Khirni, all of which provide food base for native birds and animals.

Chapter 3

Fauna

Takhe Gyati

A variety of insects such as Mantis, Grasshoppers, and Beetles, diverse grassland birds such as Munias, Prinias, Francolin and animals like Skinks, Snakes, Mongooses and Hares are found here.

Dragonflies and Damselflies are important components of wetland ecosystems. As top predators of other insects particularly mosquitoes and their larvae, these insects maintain the tropic levels and regulate the populations' sizes of disease-transmitting insects (vectors). Dragonflies and Damselflies are beneficial insects of the ecosystem and provide the health services to human well being. The full functional wetland ecosystems of Yamuna Biodiversity Park harbor as many as 35 species, that act as biological control agents.

The other winged control agents include Common Clubtail, Coromondel Marsh Dart, Pied Paddy Skimmer, Trumpet Tail and Golden Dartlet.

Butterflies are not only beautiful insects which pollinate plants, and provide food for birds and other animals, but they are also indicator of environmental health and resilience. Butterfly populations are on a world-wide decline. By growing nectar producing food plants for adults and host plants for their larvae, Yamuna Biodiversity Park is home for as many as 75 butterfly species. Some of the notable species are Common Castor, Peacock Pansy, Lime Butterfly and Common Silverline. Different life stages of butterfly species can easily be observed in Yamuna Biodiversity Park. The other insects like species of Moths, Flies, Aphids, Spiders, Bees and Wasps are also found in the conservatory.

Yamuna Biodiversity Park with abundant food and safe nesting sites has become home for many birds. Over 196 species have been recorded including resident and migratory bird species and the most easily and frequent sighted one are Parakeets,

Bulbuls, Peafowls, prinias, Munias and Shikra in terrestrial communities. Many of them raise broods each year.

Most of the forest communities have already reached to canopy height of 30-40 feet and is stratified into three layers. These biologically rich communities support animals like Civet, Mongoose, Hares, Nilgai, Jungle Cat, Wild pig and many herpeto fauna and diverse food web with three tropic levels. The breeding population of Indian Cobra is regulating the populations of peafowl and other birds suggesting the evolution, and sustainability of ecosystems developed with diversified food-web and tropic structures also.

Fauna of Phase II include 70 species of resident and migratory birds. Some of the notable species are Pheasant- tailed Jacana, Bronze-winged Jacana, Painted Stork, Asian Openbill, Eurasian Spoonbill, Ruddy Shelduck (Surkhab), Sarus Crane and many species of wader. These wetlands also serve as reservoir for the aquatic genetic resources (invertebrates, turtles, fishes, zoo and phytoplanktons) and also, serve as source population for the areas devoid of such aquatic fauna due to seasonal fluctuations in water level in the riparian ecosystem.

Chapter 4

Charismatic Species

Takhe Gyati

Yamuna Biodiversity Park is a home of not only the Indian species but of a number of charismatic species as well, which includes:

Guggul (*Commiphora wightii*): A shrub or small tree of the family Burseraceae; it yields a resinous sap known as gum guggul. Used in ayurvedic medicines and health foods.

Lemon Grass (*Cymbopogon citratus*): A perennial grass used widely in Asian cuisine such as tea, soups and curries.

Khirni (*Manilkara hexandra*): A locally extinct tree of the family Sapotaceae, Khirni produces very sweet edible fruits, which once upon a time was plentiful in the markets.

Anjan *(Hardwickia binata)*: A member of the family Caesalpiniaceae, Anjan is a tropical dry deciduous tree found in Teak and Sal forests and yields valuable timber. It has elegant foliage and is grown as avenue tree.

Haldu *(Adina cordifolia):* A deciduous tree of the family Rubiaceae; an important tree of both moist and dry deciduous forests of India and yields valuable timber.

Oriental Darter (*Anhinga melanogaster*): A predominantly tropical waterbird of the family Anhingdae, Darter is a near threatened species, and hence require conservation attention for securing it. However, it has been breeding every year in the wetland of the Biodiversity Park.

Red Throated Flycatcher (*Ficedula parva*): It is small passerine winter migrant in the Park.

Barn Owl (*Tyto alba)*: It is one of the four owl species found here and can be easily identified by its heart shaped facial disc marking.

White Browed Fantail (Rhipiduraaureola): It is a small passerine bird found in woody areas of the Park.

Common Indian Krait (Bungaruscaeruleus): Identifiable by a dark steel-coloured body with prominent white marking, krait is one of the venomous snakes found in forest communities of this biological home.

Signature spider (Argiopeaemule): A spider which is uncommon in Delhi but abundant in over here.

Chapter 5

Techniques and Processes Involved

Darshan Regi Kalathil

The land on which the Yamuna Biodiversity Park now stands was a marshland over run with rodents. Developing the marshland into a self sustaining ecosystem was no easy task. Unlike the other conservatoriums, it aims to find solutions using natural methods; the goal being to make it a self sustaining ecosystem as fast as possible.

Soil

One of the first challenges faced by the team was the high soil salinity of the marshland that was to be reclaimed for the Biodiversity Park.

Salinity was checked by **Phytoremediation**. Phytoremediation describes the treatment of environmental problems through the use of plants that mitigate the environmental problem without the need to excavate the contaminant material and dispose of it elsewhere. Hence, to treat salinity, grasses that absorb salt were planted first.

These grass species include *Suaeda pluticosa, Bothriochlora, Lepto chloaeptocoa, sporobolusmos*, etc. These species thus became the pioneer species of the Yamuna Biodiversity Park in a bid to reduce the salinity levels of the land.

Salinity was also kept under check by using gypsum initially. Gypsum is calcium sulphate. The most common form of it is the dehydrate which means that each molecule of calcium sulphate has two water molecules associated with it. It is expressed as $CaSO_4.2H_20$.

In addition to prevention and correction of salinity, other uses of gypsum include: greater stability of soil organic matter, more stable soil aggregates, improved water penetration into soil, and more rapid seed emergence.

Calcium from gypsum has a physiological role in inhibiting the uptake of sodium by plants.

The soil is checked monthly for salinity, pH, electrical conductivity, water holding capacity, nitrates, phosphates, and other minerals. The water in all the wetlands have to be checked for Zinc Levels and Total Dissolved Salts (TDS) apart from the other tests mentioned above for soil.

Forest

The forest covering the Biodiversity Park was initially all transplanted from indoor nurseries. Ten years on, the forest is self-regenerating. The nurseries maintained at the Biodiversity Park are still used to germinate seeds but these are mostly sent to the other Biodiversity Parks in the NCR on demand.

The Poly House

A polyhouse works on the same principle of a green house but is made of polyethylene instead of glass. The interior heats up because incoming solar radiation from the sun warms plants, soil, and other things inside the building faster than heat can escape the structure. Air warmed by the heat from hot interior surfaces is retained in the building by the roof and wall. Temperature, humidity and ventilation can be controlled by equipment fixed in the polyhouse.

Polyhouses have been hailed by farmers all over the world for enabling them to grow crops throughout the year, irrespective of weather conditions. The yield is as good as open field farming, if not better. In India, farmers have been able to

successfully grow tomatoes before the winter season, when there is usually a price hike for the same.

Polyhouses are used at the Biodiversity Park to germinate seeds that normally would not be able to do so in the wild. They are also used to germinate seeds throughout the year as waiting for monsoon is not always a viable option.

Trees like the wild *Kadam* had to be germinated in the poly house. Seedlings are kept there for three to five days before they are transferred to the nethouse.

The Net House

A net house is a framed structure made of materials such as GI pipes, angle iron, wood or bamboo. It is covered with a plastic net (Polyethylene) having different shade percentages. It provides partially controlled atmosphere and environment by reducing light intensity and effective heat during day time to plants grown under it.

Once the seedlings are transferred to the net house, they are kept inside for two to three months so that they can adapt to the environmental conditions outdoor. The plants are further monitored in a nursery for 6months, up to a year. During the monsoon season, the saplings are directly transplanted from the net house to the park.

Chapter 6

Interviews of the People

Darshan Regi Kalathil

Multi-Taskers

The Yamuna Biodiversity Park employs multi taskers who form the backbone of this endeavor. They are usually hired from agricultural communities from neighbouring lands or transferred from the Garden Committee of the University of Delhi.

We spoke to **Mr. Devaraj Ji,** a multi tasker at the Yamuna Biodiversity Park since its inception. Mr. Devaraj Ji is from a agricultural family from a village near Delhi, in Uttar Pradesh. He had been employed as a gardener by the Garden Committee of the University of Delhi since 1964. While working for the biodiversity park, he had to learn so much more despite his background.

He told that different species that had to be originally planted needed different methods of care. Farming at home and gardening at the University had been fairly easy because of the good soil and water at these places. The Biodiversity Park is located on what used to be a wasteland with high saline levels and full of rats. Initially, six to four out of ten saplings would die.

Reducing salinity levels using phyto remediation and gypsum improved the quality of the soil. After the plants took to the soil, snakes moved in to the park and has since kept a check on their population.

Some of the multi taskers are sometimes assigned special areas of the park to look after and they eventually develop a sense of specialization in that area. Hence, on job learning is very crucial for them.

Another multitasker we spoke to was **Mr. Pritish Kumar Misra** who was living in Delhi since 2000 and had joined the Yamuna Biodiversity Park in its initial face, in 2002. He had seen the development taking place and also the tackling of problems like that of rats invasion etc. He said that the specialists at the Biodiversity Park were open to the new and indigenous ideas of the multitaskers and they also look forward for the suggestions by them. They also incorporate the practices if found useful. According to him, the field was an open laboratory and hence, people gained experience by absorbing the knowledge and not through a proper training.

The Experts

Mr. D.P Srivastava is an Education Officer with the Yamuna Biodiversity Park. It was him who took us around Phase II along with **Mr. Sameer Gautam** and explained the various activities of the park. They also gave us insights into the working of the Park and their mission. They told us that the aim of the Park is to make this 457 acre area self sustaining but it is only possible through human intervention. The wasteland had to be thoroughly landscaped to make it the forest it is today. Salinity levels were reduced with phyto- remediation and the sub soil quality was improved by making mounds. Wetlands also had to be created within the park.

All these are natural methods which have been fast forwarded through human intervention. The plant succession that is present today would have taken over a hundred years to develop. Here, it has been achieved in about ten years. Some of the sites responded in as little time as three years to the soil treatment.

Working at the Yamuna Biodiversity is a field job. The office building is used only for meeting visitors from outside. All the multitaskers and experts are always required on the field.

Chapter 7

Auto-Rehabilitation through Biodiversity

Singmichon Keishing

Everything in the natural world is connected. Ecosystems have no particular size. An ecosystem can be as large as a desert or a lake or as small as a tree or a puddle. If you have a terrarium, that is an artificial ecosystem. The water, water temperature, plants, animals, air, light and soil all work together. If there isn't enough light or water or if the soil doesn't have the right nutrients, the plants will die. If the plants die, animals that depend on them will die. If the animals that depend on the plants die, any animal that depend on those animals will die. Ecosystems in nature work the same way. All the parts work together to make a balanced system!A healthy ecosystem has lots of species diversity and is less likely to be seriously damaged by human interaction, natural disasters and climate changes. Every species has a niche in its ecosystem that helps keep the system healthy.

In a lake ecosystem, the sun hits the water and helps the algae grow. Algae produces oxygen for animals like fish, and provides food for microscopic animals. Small fish eat the microscopic animals, absorb oxygen with their gills and expel carbon dioxide, which plants then use to grow. If the algae disappeared, everything else would be impacted. Microscopic animals wouldn't have enough food, fish wouldn't have enough oxygen and plants would lose some of the carbon dioxide they need to grow.

Ecosystems have lots of different living organisms that interact with each other. The living organisms in an ecosystem can be divided into three categories: **Producers**, **Consumers** and **Decomposers**. They are all important parts of an ecosystem.

Producers are the green plants. They make their own food. Consumers are animals and they get their energy from the producers or from organisms that eat producers. There are three types of consumers: herbivores are animals that eat plants, carnivores are animals that eat herbivores and sometimes other carnivores and omnivores are animals that eat plants and other animals.
The third type of living organism in an ecosystem is the decomposers. Decomposers are plants and animals that break down dead plants and animals into organic materials that go back into the soil.

Soil is a critical part of an ecosystem. It provides important nutrients for the plants in an ecosystem. It helps anchor the plants to keep them in place. Soil absorbs and holds water for plants and animals to use and provides a home for lots of living organisms. The atmosphere provides oxygen and carbon dioxide for the plants and animals in an ecosystem. The atmosphere is also part of the water cycle. Without the complex interactions and elements in the atmosphere, there would be no life at all!The heat and light from the sun are critical parts of an ecosystem. The sun's heat helps water evaporate and return to the atmosphere where it is cycled back into water. The heat also keeps plants and animals warm. Without light from the sun there would be no photosynthesis and plants wouldn't have the energy they need to make food.

Without water there would be no life. Water is a large percentage of the cells that make up all living organisms. In fact, you may have heard that humans can go longer without food than they can without water. It's true! Without water all life would die. In addition to being an important part of cells, water is also used by plants to carry and distribute the nutrients they need to survive.

Ecosystem processes are broad generalizations that actually take place through the actions of individual organisms. The nature of the organisms—the species, functional groups and trophic levels to which they belong—dictates the sorts of actions these individuals are capable of carrying out, and the relative efficiency with which they do so. Thus, ecosystem processes are driven by the number of species in an ecosystem, the exact nature of each individual species, and the relative abundance organisms within these species. Biodiversity plays an important role in ecosystem functioning.

Ecological theory suggests that in order to coexist, species must have some level of limiting similarity—they must be different from one another in some fundamental way, otherwise one species would competitively exclude the other.

The above mentioned activities, interactions, processes are no different from what it is in the Yamuna Biodiversity Park. When species are introduced and there is diversity among them, interactions among them automatically arise and this is a nature's work. Interactions among different species in an ecosystem of the Park and how it enhances the health of an overall ecosystem could be briefly explained with

the following examples. The ecological diversity within the wetland habitats sustain rich flora and fauna. A wide range of birds and other benthic fauna and fishes are attracted by the high-productivity of abundant phyto and zooplanktons and submerged, floating and emergent aquatic vegetation. Migratory water bird species like Ferruginous Pochard, Common Pochard, Northern Shoveler, etc. started visiting the park every year increasing the species richness of the park. Birds started reproducing and thus the park is now a permanent home to around 35 species of birds. Few examples are the Spot-billed Duck, Grey and Purple Herons, Oriental Darter, Little Cormorants, Indian Cormorants, etc.

A variety of ecological services are also generated by the grasslands and rangelands . Even not directly introduced, a variety of insects such as Mantis, Grasshoppers, Beetles started to arise automatically. Diverse herbal plants, grassland birds and animals such as Francolin, Munias, Prinias, Snakes, etc. also started to find their way to the park and permanently live there.

There are 30 different forest communities, consisting of 850 plant species, maintained in Yamuna Biodiversity Park. Many new samplings are seen spruting every year indicating that they have found their ideal habitats. Reproduction is a fundamental feature of all known life. Also the most fundamental property of evolving systems is their ability to *replicate* or *reproduce*. Without this ability of *reproduction*, each "species" of molecule that might appear is doomed to extinction as soon as all its individual molecules degrade. It also helps in creating populations.

It is always better to live in community than to live alone. These communities have provided ideal habitats for different animal and bird species. For example, Herons and other wetland bird species have found their homes in Riparian community and animals have found their homes in the forest communities. These animals are breeding every year and their breeding is controlling the populations of other species, that otherwise not controlled will be harmful to the healthy functioning of the ecosystem. For example, the breeding population of Indian Cobra is regulating the populations of Peafowl and other birds suggesting that the evolution and sustainability of the ecosystem developed with diversified food web and trophic structure.

Several tropical and sub-tropical fruit yielding trees and shrubs are also grown which have become the food source for the birds and animals.

The wetland ecosystems also have around species of winged biological control agents like dragonflies and damselflies which are important because they are the top predators of other insects specially mosquitoes and their larvae. They maintain the trophic levels and regulate the population sizes of disease-transmitting insects (vectors). A number of butterfly species are found which help in pollination which

is a vital process for procreation of new baby plants. They are also a food for some birds. Moreover they are indicators of environmental health and resilience.

The Park also possesses a rich aquatic communities consisting of species like Pheasant-tailed Jacana, Painted Stork, Eurasian Spoonbill, etc. It is because of the ideal habitats provided by the wetlands. The aquatic genetic resources like invertebrates, turtles, fishes, zoo and phytoplanktons are preserved in these wetlands. Due to the seasonal fluctuations in water level in various ecosystems, these wetlands also serve as a source population for the areas devoid of aquatic fauna. Ecological indicators are useful for tracking or monitoring an ecosystem's status and can provide feedback on management progress. For example, in the Biodiversity Park Typha and Phragmatis are used as indicators of soil moisture

As we have seen, interactions among the species are vital for the survival of every species and for the healthy functioning of the ecosystem. All the species are interdependent and interconnected to each other that any damage to one species will directly or indirectly affect the others too.

The association of biodiversity and urban ecosystems has usually concerned the impact of urbanization on biodiversity. However, biodiversity concepts can easily be applied to the urban ecosystem itself. As more and more people live in cities, restoration, preservation and enhancement of biodiversity in urban areas become important. Concepts related to biodiversity management such as scale, hierarchy, species identity, species values, and fragmentation, global approaches can be used to manage urban biodiversity. Application of these concepts in such artificial ecosystems may yield important insights for the management of natural ecosystems. Birds are highly visible and quite sensitive to changes in habitat structure and composition. Bird species richness in urban ecosystems is influenced both by local and landscape characteristics and a multi-scale approach is essential to its proper management. People–wildlife conflicts are an integral component of wildlife management in urban ecosystems and must be addressed. Enhancement of biodiversity in urban ecosystems can have a positive impact on the quality of life and education of urban dwellers and thus facilitate the preservation of biodiversity in natural ecosystems.

Around 30 forests communities of Yamuna River Basin are recreated in the Park having diverse ecological niches that not only attract a wide range of animal species but also enable them to build viable populations. The ecological diversity within the wetland habitats sustains rich flora and fauna. The biodiversity profile of YBP in the year 2014 is as follows;
Plants (including medicinal plants, aquatic plants, grass) – 874 species
Butterflies -75 species.
Dragonflies and damselflies – 35 species.
Birds – 196 species

Reptiles – 18 species
Mammals – 18 species
Fishes – 18 species
Other animals including amphibians and invertebrates – 400 species

The Yamuna Biodiversity Park has been made with **Ecosystem-based management** which is an environmental management approach that recognizes the full array of interactions within an ecosystem, including humans, rather than considering single issues, species, or ecosystem services in isolation (Christensen et al. 1996, McLeod et al. 2005). In light of significant ecosystem degradation, a holistic approach was employed, that combines environmental knowledge and co-ordination with governing agencies to initiate, sustain and enforce habitat and species protection, and include public education and involvement. Whole-ecosystem approaches to management ensure not only the survival of species and scenic vistas, but also allow these systems to continuously evolve and change.

A focus was made not on a single, end-all goal, but instead on a combination of goals and their relationships with each other.

UNIT V
RESULTS AND ACHIEVEMENTS

Chapter 1

Achievements

Priya Vidhuri, Suprigya Deepangi and Naveen Kumar

Yamuna Biodiversity Park is a unique landscape, designed in house by DDA which, like nature reserves, harbors hundreds of vanishing species living together in the form of diverse communities and provide ecological, cultural and educational benefits to the urban society.

Thus, Biodiversity Parks act as heritage sites and repositories of the approximately 50, threatened communities of the Yamuna river basin and Aravali hills, provide ideal alternative habitats for migratory and resident bird species, enhance ground water recharge and augment fresh water availability, act as sinks for CO_2 and other pollutants, ameliorate local weather conditions and buffer ambient temperatures, promote eco-tourism and social connectivity across the urban community, serve as gene pools, and represent unique ecological models possessing not only wildlife and natural values but also aesthetic, environmental and educational values.

It is now well understood that the last century has seen unprecedented loss of ecosystems that flourished on the banks of river Yamuna, the Siwalik foothills, and the northern limits of the Aravalis. This has occurred primarily owing to habitat conversion and urbanization. The unique habitats in these areas harbored extraordinary diversity of flora and fauna, which are now either lost or highly diminished. One of the major objectives of the Biodiversity Parks is to create refuge for such biodiversity so that is can be conserved for posterity.

In a short span of ten years, the dedicated team of professional and volunteers at the Park have been able to bring back a large number of plants and animals and recreate representative communities and ecosystems.

The journey of the milestones that the park has achieved in different years is as follow :

June 2002: Project Initiated

December 2002: Shallow Wetland, Habitat improvement ptogramme undertaken.

June 2003: Plantation of natural communities commenced

June 2004:Deep Wetlands and Visitor Area landscaping completed

June 2005: Grassing and plantation of legumes

June 2006: 20 biotic communities established and a new marsh land developed.

June 2007: A new marsh land to attract waders

June 2008: Amphitheatre, Butterfly conservatory became functional

June 2009: Wetlands became functional ecosystem

June 2010: Many trees attained canopies and several bird and animal species started breeding

Since then, the park is flourishing actively and new flora and fauna could be seen which is evident of the auto-rehabilitation that is taking place in the park. Each time the experts discover a new flora emerging or a sign of a new fauna, it's an achievement for them. The activities going on in the wild are keenly monitored by the officials and are kept a record of. They still expect a lot of biodiversity to come up to help the park in becoming more self sufficient.

Chapter 2

Maintenance

Tanzeel Azad and Kirti Sharma

Yamuna Biodiversity Park is slated to act as a repository of approximately a number of threatened communities of Yamuna river basin. It is being developed over an area of 456 acres. This park comprises of poly house, net house, interpretation center, main nature trail, water bodies and wetlands with ancillary facilities in visitors' area. It is emerging as the capital's most visited public place and prominent center for learning and understanding the environment. The park also comprises native flora and fauna which used to exist 100 years ago and then became extinct locally.

The park and its maintenance needs are being fed by the continuous government involvement including DDA and other programs. Different processes undertaken by the experts help maintain the park. The soil of Yamuna Biodiversity Park was initially highly alkaline and sandy with pH up to 9.8 making it extremely difficult for the wild native species to survive. By undertaking plantation of specific grasses and legume plants, remarkable habitat improvement has taken place with pH varies from 8.2 to 7.6 across the habitat types today. All this is achieved through biological remediation and no chemical fertilizers, insecticides are being used in the park.

It also has maintenance help from the local village communities who help in the multi-tasking works like digging and cutting. Also the Delhi Jal Board also helps in drilling the surface and the roads around. A careful observation of the life and ecosystem around the park is made so that different aspects of different life forms can be more keenly understood. This is also done by filming and photography. Close monitoring of interaction of different species is done so that better environment could be created to ensure their survival.

Plantation drives are usually conducted during the monsoon season. The unwanted species are looked upon during the winter season. It has efforts vested upon by many scientists to create a healthy environment for hundreds of individuals who develop different ways to maintain the park area. Since its goal is to preserve the threatened life forms by creating field gene banks, it can go further in its study and adaptation process.

Chapter 3

Public Involvement and Outreach

Tanzeel Azad

Since its initiation in the year 2002, the Yamuna Biodiversity Park has emerged as a destination for first-hand knowledge on nature education, attracting more than 15,000 students each year. In the year 2004, a Visitor area landscape was completed to be established for further outreach. Since it is still in its process of development, and is not yet fully established, its public services and outreach are limited. It is not officially open for public but people still visit the Park, mainly for general learning. The Park is home to about 20 natural communities who play an important role in its conservation. The Park has some communities living around the Jagatpur area in the south. The villagers living there have respect for the Park and help in its maintenance. Though, the new colonies made through the northern side do not have much respect for it.

Teams of scientists pay visits to the Park. In addition, trips of school students also come for nature education, usually during winters. The government has been successful in establishing camping facilities in the Amravati Park and is looking forward to doing so in the Yamuna Biodiversity Park. Apart from the education related visits they get from students, scientists from different countries, general public visitors, NGOs, and other government servicemen also visit the Park. Volunteering, internships and certification opportunities are less, though available during winters when students come for visits. More opportunities will gather as the Park moves towards its full establishment.

UNIT VI
CONCLUSION

Rashi Agarwal

The project of Yamuna Biodiversity Park, on the banks of river Yamuna has come out to be a very successful initiative to restore the lost pristine of Delhi. With the revival of the lost species of both flora and fauna, the park has been able to set a huge milestone. A large number of species which had got extinct hundreds of years ago can now be seen actively flourishing in the park along with their own ecosystems including birds, animals, micro-organisms and rodents.

The project aimed at conserving and preserving the two major landforms in Delhi: Aravali range and the Yamuna basin. Extensive fieldwork and research on the biodiversity along the river Yamuna helped in the creation and management of the park. Though, initially ex-situ conservation provided reservoirs of individuals for infusing and restocking wild populations of endangered species, the Biodiversty Park has now become an example of in-situ conservation also due to auto-rehabilitation through biodiversity.

It acts as a repository for more than 1,00,000 individuals of plants belonging to 800 species in its communities, accompanying a number of species of birds, butterflies, mammals, fish, rodents, fruits, medicinal plants etc. The wetlands of the park need special mention as they attract thousands of migratory birds from different places across the globe belonging to different species, each year. With the high degree of interdependence of flora and fauna on each other, the Park exemplifies itself to be almost self-sustaining now, minimizing the need for human intervention in the process. The concept of biodiversity and ecosystem can very well be seen there, which illuminates the understanding of the variations in the biological environment and their relationship with the abiotic components.

The biological homes, thus, act as museums for the lost biodiversity and provide new habitats for the vanishing species. They help in reviving the old lost environment and ecosystem and act as the gene pool for native species. Thus, they not only preserve wildlife but also act as natural assets for aesthetic, environmental and educational values. The park throws vivid light on the importance of such biological homes which serve as the carbon sinks. Rich in local flora and fauna, such place attracts scientists, students as well as public from different corners for learning and recreational purposes.

The guiding principles behind the conservation of Yamuna Biodiversity Park have always been sustainability and indigenous knowledge along with the incorporation

of the scientific research and maintenance strategies. Even Prof. C. R Babu said that from a long-term perspective, sustainable development is the only solution that meets the needs of the present, whilst at the same time preserving the world's natural heritage for future generations.

The park indeed has been appreciated not only by the researchers, scientists, ecologists and environmentalists but also by local people. Mr. D.P. Srivastava says that the local people have started appreciating their endeavours as it is not only helping them economically, but also helping them indirectly, by improvising the surrounding area. He further says that when the park organizes public gathering, plantation drives etc, local people do actively participate and appreciate their efforts extensively.

The concept of biodiversity has taken hold at the crossroads of natural sciences and social sciences. The natural sciences have been marginalized for some time and are striving to regain public interest; the social sciences are discovering the complexity, but also the richness, of the relationship between humankind and nature. Both sciences approach biodiversity as a field of application for the new relationships that are developing between humans and nature, raising new questions and concerns regarding the living world.

The relations of science and society are fully reciprocal. Just as transformations are produced inside science by social events, so,…have social transformations been brought about through the effects of science.

Bernal (1968:1233)

Biodiversity has now become a social issue. It appeals to new moral values that question the priorities of economic models of development. Decision-makers and producers have started being pressurized to change their relationship with natural science specialists who, are now called upon to help degraded environments, recover their biological integrity, their functions and ecological services.

Preservation of the biodiversity that is our heritage requires local management by the populations immediately concerned. Centralized management forms, advocated by Western societies in accordance with their own perceptions of nature and moral values, have limited universal validity. Conscious that it is in the nature of international law to lag behind events and that considerable economic interests are involved, it is legitimate to ask what the real implications of potential protective measures are. The shape of the future will necessarily depend upon the ways in which societies and scientists are able to make themselves heard by the policy-makers of today.

The use and conservation of biological diversity generates fundamental conflicts of interest. Their resolution is contingent upon the choices made by society concerning economic progress and the exploitation of biological resources. For some, priorities may be ethically founded and/or inspired by religious belief. For others, the present or potential economic value of biological diversity is sufficient justification to project and implement investments in conservation. The transition takes a lot of time, research and effort but they definitely lead to fruition later on.

Given the popularity and the advantages of such biodiversity parks, governments of the other states like Karnataka and Maharashtra have also started coming up with the idea of the preservation and conservation of the biotic components around them. Not only this, different localities in Delhi are also proposing to have such reserves for their future generations and also because of their aesthetic, artistic, educational, spiritual and scientific values. If such continues to happen, the day is not far when we would have the biodiversity parks in every district to revive the endangered local species. Such a step would definitely, help us in heading towards sustainability and make Earth a better place to live in.

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