Management Plan
of
Asola Bhatti Wildlife Sanctuary,
(Govt. of NCT Delhi)
2015-16 to 2024-25

Prepared By

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MANAGEMENT PLAN OF ASOLA BHATTI WILDLIFE SANCTUARY

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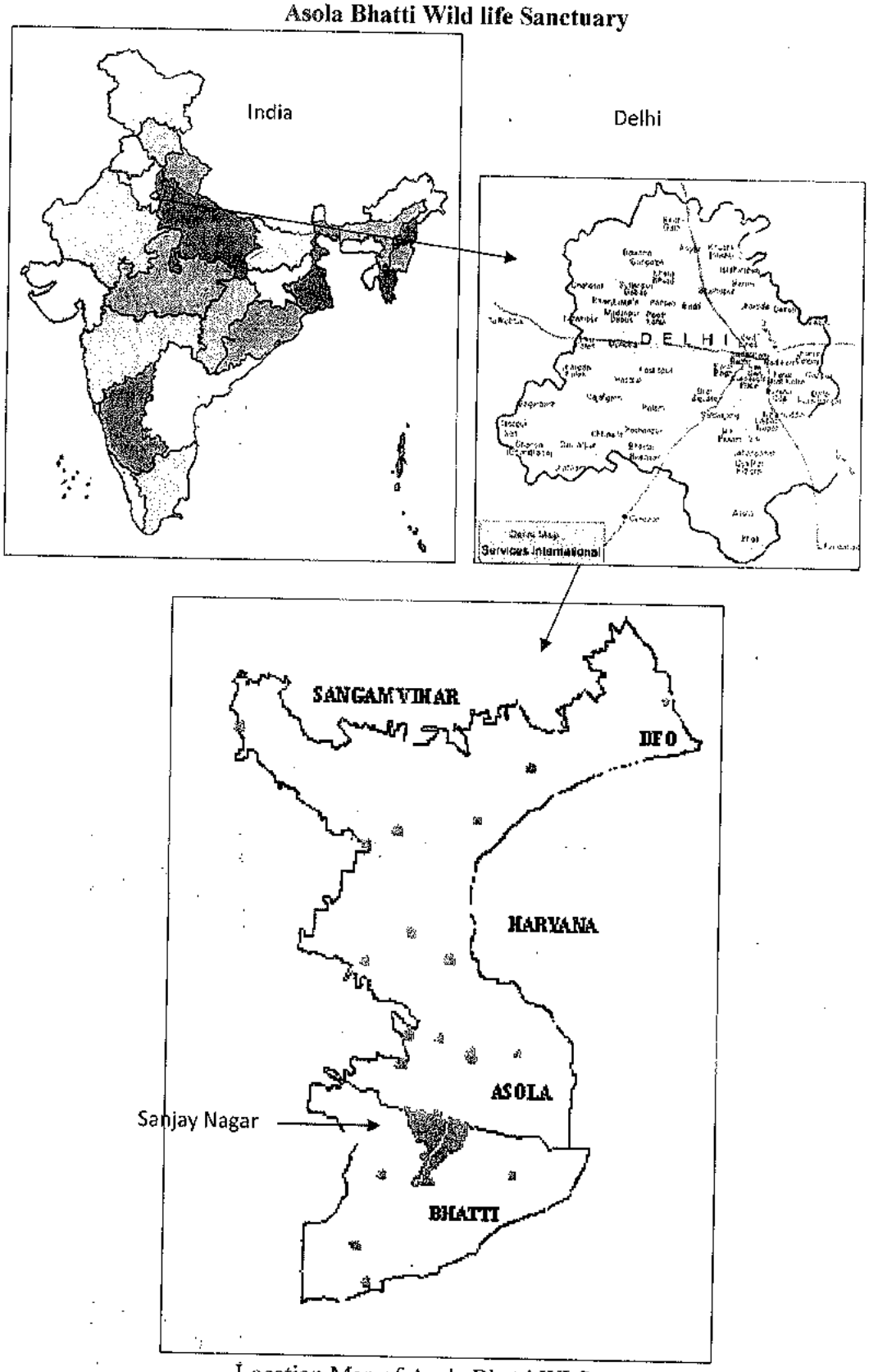

Location Map of Asola Bhatti WLS

EXECUTIVE SUMMARY

The Government of NCT of Delhi considering the ecological, faunal, geo-morphological significance had declared the Gaon Sabha lands including abandoned mining pits in Bhatti are area of Southern Ridge as Asola-Bhatti Wildlife Sanctuary for the purpose of protection and development of forests/improvement of habitat vide Notification dated 09.10.1986 and 15.04.1991. The total area of the sanctuary is 6873.28 acres. The Sanctuary is quite different from the popular perception of the protected area mainly because of its use and abuse done in past by way of active mining done in past for quartzite sand, commonly known as "Badarpur". Various other anthropogenic pressures like transportation of truck loads of Badarpur sand, livestock grazing, fuelwood collection, fodder collection had heavily scarred and severely degraded the area.

The sanctuary serves important functions at landscape, regional and local levels. Being the seat of Transition Zone from Semi Arid to Gangetic Plains Bio-geographic zone, the entire Asola – Bhatti WLS could act as an effective barrier against the advancing aridity from South West direction. It is conveniently accessed and ideally located to act as a centre for Biodiversity Conservation, Education & Nature Interpretation programme to spread the message of awareness about the nature & environment amongst nature lovers and school children. The deeply dug mining pits of the past, few of them are of gigantic dimensions act as stop over destinations for migratory birds. There is potential for improvement in local ground water recharge. The sanctuary besides conservation, is a site for "Green Lung" an carbon sink for city sour Delhites.

Vegetation of ABWLS falls under **northern tropical thorn forest type(6B/C).** The vegetation is predominantly an opened canopy thorny scrub and capable of draught resistance. The common tree species as per abundance are *Prosopis juliflora, Butea monosperma, Azadirachta indica, Dalbergia sissoo, Dyospyros montana, Wrightia arborea, Holoptelia integrifolia, Zizyphus nummularia, Flacourtia indica etc.* The common shrubs found are *Lantana camara, Capparis sepiaria, Hibiscus ovalifolius,*

Maytenus senegalensis etc. The common climbers are *Asperagus racemosus, Ipomoea pestrigridis, Telosma pallida, Ziziphus oenoplia, Jasminum multiflorum, Cayratia trifolia.* Among herbs found in the area are *Achyranthus aspera, Cammelina bengalensis, Peristrophe paniculata, Sida cordata, Triumfetta rhomboidea* etc.

The faunal diversity consists of 18 species of Mammals belonging to 10 families and 7 orders. The main herbivores of the sanctuary are Blue bull/nilgai (*Boselaphus tragocamellus*, Black buck (*Antilope cervicarpa*), Porcupine (*Hystrix indica*), *Rhesus macaque* (*Macaca mulatta*), Hanuman langur (*Presbytis entellus)*, Common hare (*Lepus nigricollis*). Among the carnivore Jackal (*Canis aureas*), Jungle cat (*Felis chaus*) are found. Presence of Hyaena(*Canis hyaena*) is also reported. The other species found in the area are Palm Squirrel (*Funambulus pennantii*), Small Indian civet (*Viverricula indica*), Small Indian Mongoose (*Herpestes javanicus*). Indian Grey Mongoose(*Herpestes edwardsii*) Indian pangolin(*Manis crassicaudata).* Approx. 82 species of birds are reported from WLS & neighbouring ridge area. Five amphibian species and three species of fishes are reported in the P.A area. Among the reptiles one species of snake and four species of lizards are reported. Twenty five species of butterflies belonging to five families are recorded.

Three villages namely Sanjay colony, Indira colony and Balbir colony are situated inside the sanctuary. The other adjoining villages around the sanctuary are Satbari, Sahurpur, Maidangari, Deoli, Anagpur and Surajkund. Many unauthorized residential colonies like Sangam Vihar have been settled in the fringe of the sanctuary. It remains to be one of the main sources of anthropogenic pressure for both the sanctuaries. Grazing by free ranging cattle, collection of fuel wood by head load, garbage disposal and even cutting of green trees to meet up firewood requirement are few challenges which needs to be tackled. Protection of the sanctuary from the vast sea of people to conserve it as a green lung and carbon sink for entire capital is one of the main objectives of the management authority. Few of the objectives of earlier Management plan prepared by WII have been achieved. The restoration of highly impacted habitat has been achieved to a considerable extent. The area now gives a look of a green patch of forest and the

scarred mine pits of Bhatti area present a look of canyon like topography full of greenery at the bottom and lower slopes of pits.

The release of over 18,507 monkeys from Delhi city inside the sanctuaries has put pressure beyond its carrying capacity. In order to keep the population of trans-located monkeys under control and to create food base for them in their new habitat, meaningful and effective management interventions have been prescribed in the Management Plan.

The Management Plan for 2014-15 to 2024-25 addresses various strategies as follow taking into consideration the various constraints:-

1 Zonation and Zone Plan for achieving long term goal and improving wildlife management
2 Rejuvenation and enrichment of vegetation conforming to Aravalli ranges in the highly impacted habitats to improve natural food base for fauna.
3 Special habitat restoration for primates by way of fruit bearing trees.
4 To establish a dynamic system of nature interpretation and conservation education in providing meaningful wilderness experience.
5 Removal of Lantana and other weeds to help regeneration, preserve bio-diversity and reduce incidence of fire
6 Improve ground water recharge by way of water harvesting and soil erosion control measures. Continuous water supply to fauna during dry season.
7 Protection against encroachment, cattle grazing, and illegal felling in future.
8 Enhancing the management capability of field staff.
9 Monitoring wild life health and population
10 Strengthening of the research and monitoring component for sanctuary

With the prescriptions, the MPO feels that the new Management Plan will help, the management authorities in restoration of habitat and in achieving the desired goals.

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CHAPTER – 1

THE PROTECTED AREA: THE EXISTING SITUATION

1 Introduction to the Area

The earlier Management plan of Asola-Bhatti WLS of NCT of Delhi was prepared by WII in 1995. This was the first Management Plan after creation of the Sanctuary in 1986 (Asola WLS-4707 acres) and 1991 (Bhatti WLS-2107 acres). Both Asola and Bhatti WLS fall within the Southern Ridge and are contiguous to each other. For convenience this will be referred as Asola-Bhatti WLS. The active mining of quartzite sand, commonly known as "Badarpur" had heavily scarred and severely degraded the Southern Ridge, which was notified as Bhatti WLS in 1991, putting a halt to the large scale mining activity. The mining activity continued across the border in Haryana (adjoining Bhatti WLS) and near Gujriwala in Delhi till – 1995.

It was for putting the halt to any further degradation of the already heavily scarred and impoverished land and to safeguard the potential biological values and ecological functions of these lands, that the mining activity was untailed and Asola & Bhatti area were notified as Wildlife Sanctuaries in 1986 & 1991 respectively. Management activities oriented towards restoration of these degraded lands using natures own processes and supplemented by human efforts and preservation of its ecological values by seeding, planting and restricting human presence began fast and by the time the last Management Plan was prepared it had begun and now after 15 years the entire area is green with lush growth of trees & shrubs harbouring good population of Nilgai & peafowls along with many other faunal species including birds and butterflies. The striking canyon like features created by deep mining now present aesthetic landscape including creation of a large perennial lake which attracts large number of migrating birds. There is a cursory mention of this lake in the last M.P. as an aquifer in the mined pit and unavailable to ungulates but this is now a huge lake of depth at centre exceeding 100ft or more. The restoration process that has taken place so remarkably is of significant educational value. These efforts have brought back the floral & faunal communities to a great extent in this ancient landform of Aravali hills which is of unique bio geographical importance. The citizens of Delhi whose quality

of life was severely affected by high level of pollution, must now recognize and appreciate the value of this green patch of forest which is an oasis in the vast expense of concrete jungle all around, as the "green lungs" of our capital city. This small fully green patch of forested lands along the Aravali Ridge remains the only green area in the vicinity which for over 12 million people of Delhi has a crucial role in pollution absorption and environmental amelioration and also as barrier against the Sand storms from west. It is the seat of conservation for various indigenous flora and fauna. Asola Bhatti WLS is located in the South eastern part of the Southern ridge. This incidentally falls amidst urban conglomeration of Delhi, Gurgoan and Faridabad and potentially is very good platform for conservation education plan for students as well as scholars and ultimate beneficial aspect is that it is a natural line of defence against soaring mercury for denizens of NCR.

1.1 Name, Location, Constitution and the Extent of Area

1.1.1 Name

Asola – Bhatti Wildlife Sanctuary derives its title from the names of two places. The first name Asola is from the name of a village Asola in South district Delhi and the second half of the title Bhatti is from the erstwhile Bhatti mining areas, which are now abandoned.

1.1.2 Location

Ridge Forest

Delhi extends over a flat-topped hill known as 'ridge', which is northern terminal of Aravalli hills (Khanna and Sati, 2003). Delhi ridge forest is an extension of Aravalli mountain range, which is oldest mountain range in India and one of the oldest mountain ranges in the world. This mountain range separates Delhi from the near-by desert state of Rajasthan, thus acting as a natural barrier (Anon., 2006). The Aravalli range spreads for 800 km from Delhi to Ahemdabad. Ridge forest of Delhi is a green patch, which is considered to be 'green lung' and 'carbon sink' for Delhi (Naithani *et al.*, 2006). Total area of ridge is 77.77 km^2 (Khanna and Sati, 2003), which accounts for about 6% of Delhi's land area. The entire ridge forest has been sub-divided into 4 distinct zones (Fig. 1.2), by Naithani *et al.* (2006):

1. *The north or old Delhi ridge*- It being the smallest part of ridge, lies to the west of river Yamuna (Anon., 2006). About 170 ha of this zone has been declared as a reserve forest in 1915, out of which only 87 ha area has been left in this zone at present, due to encroachments, settlements, and illegal constructions etc. (Naithani *et al.*, 2006),
2. *The central or new Delhi ridge*- It occupies a comparatively larger area i.e., 864 ha (Anon., 2006). It is more popularly known as Dhaulakuan ridge (Naithani *et al.*, 2006). It was also converted into reserve forest in 1914. Although some of this area has also been encroached by settlements,
3. *The south central ridge*- It is spread over an area of 633 ha and it surrounds the historical monument of Qutab Minar (Anon., 2006). Central portion of this zone had been converted into Sanjay Forest and Aravalli Biodiversity Park, and
4. *The southern ridge*- It is the largest of all four zones with an area of approximately 6200 ha. Because of its large size, remarkable efforts have been taken up for its protection, restoration and development (Anon., 2006). Keeping this in mind, this zone has been declared as a wildlife sanctuary namely, Asola-Bhatti wildlife sanctuary in 1986 and 1991(Naithani *et al.*, 2006).

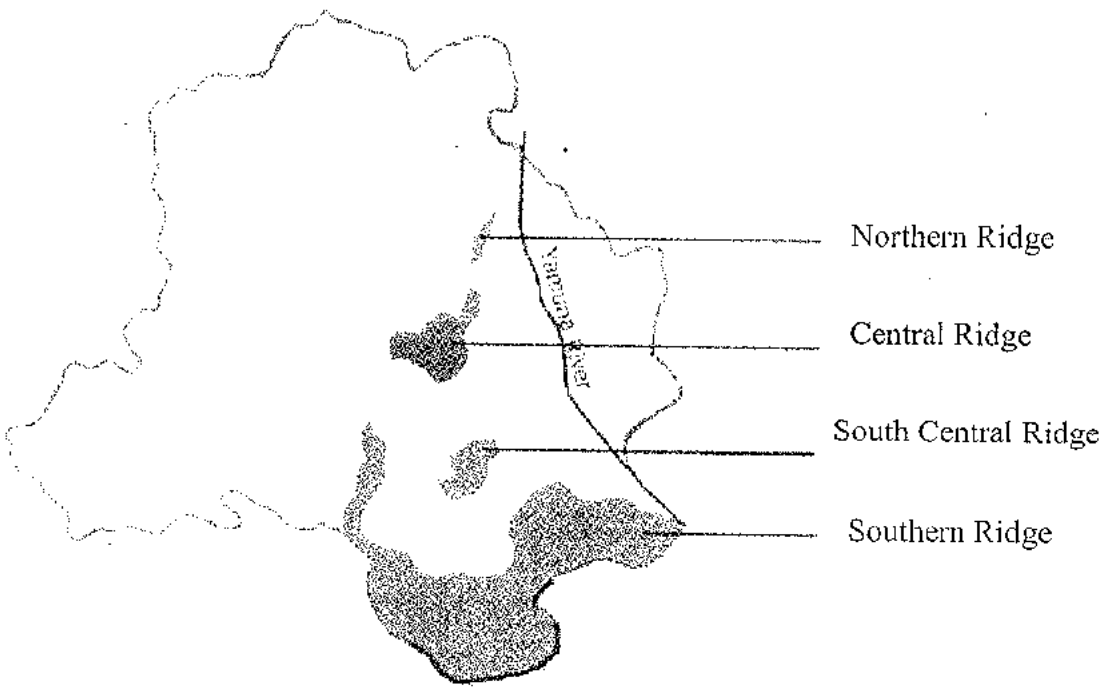


Fig.1.1: Zones of Delhi ridge (Source: Deptt. of Environment and Forests, Delhi, 2006).

Asola – Bhatti Wildlife Sanctuary spreading over 2700 ha falls in South district of Delhi state. Geographically, the Sanctuary lies between 77° 7'- 77° 15' longitude and 28° 25' - 28° 30' latitude, located in Southern Ridge of the famous Delhi Ridge. Delhi Ridge is the Northern terminal extension of the famous 800 Km long Arawali Hills one of the oldest mountain ranges in the country. The altitudinal variation in the sanctuary ranges from 130 to 320 mtr above MSL. Delhi Ridge is extending into Delhi from Gurgaon (Haryana) at the Tughlakabad – Bhatti mines – Dera Mandi axis moving northward covering areas of Asloa – Bhatti Wildlife Sanctuary. Delhi Ridge is divided into four zones viz. 1) Northern Ridge, 2) Central Ridge, 3) South Central Ridge and 4) Southern Ridge. Aslola - Bhatti WLS falls in the area of Southern Ridge. Alsola - Bhatti WLS is situated in the undulating hilly and rocky terrain of North Western terminal zone of Arawali Mountains. It falls in the administrative district of South Delhi bordering Haryana State on its Western South. Aravali Hills ranging up to 800 km in length are one of the oldest mountain ranges. Originating in south west Rajasthan they extend in North West direction towards Delhi. Bio-geographically Asola-Bhatti WLS represents the seat of transition zone from arid zone to Gangetic plains. The entire area of the PA is undulating, moderately hilly and rocky (Kalpavriksh).

Initially in area of 12858 bigha and 52 biswas measuring 4707 Acres of Gaon Sabha lands of villages Asola Sahurpur and Maidangarhi was notified under section 18 of the WL(P) Act 1972 vide notification no F3(116)/CWLW/84/897/ to 906 dated 9/10/1986, (Annexure –I). Again in the year 1991 an area of 2166.28 Acres of land in Bhatti mines area was notified as Wild Life Sanctuary under section 18 of the Wild Life (P) Act 1972 vide notification no. F2(19)/DCF/90-91/1382-91 dated 15/04/1991 (Annexure –II). Presently Asola-Bhatti WLS is extended over an area of 6873.28 Acres.

1.2 Approach and Access

The entire area of the WLS is situated on the interstate border of Haryana and Delhi and is conveniently accessed and approached by rail, road and air. There are two entry points to the WLS one is located near to the Dr. Karani Singh Shooting Range on Tuglakabad Suraj Kund road where the DCF office is currently situated. The second entry point is from Bhatti mines area. The distance of WLS from:

- Indira Gandhi International Airport Delhi is approximately 25 km
- New Delhi Railway station is approximately 25 km
- ISBT Kashmiri Gate is approximately 32 km

1.3 The Statement of Significance

Asola - Bhatti WLS represents typical seat of transition from semi arid bio-geographic zone to Indo-Gangetic plains. Located on the North Western terminal of Arawali hills, one of the oldest mountain ranges, Asola- Bhatti WLS attain its significance from its unique physiographic and bio- geographic location and rich history of ecological attributes.

- It is the only Protected Area with over 2500 ha vegetated natural area sandwiched between Delhi & Gurgoan – Faridabad Urban conglomeration of over 15 Million population. It falls in the semi arid bio geographic zone as per Rodgers & Panwars bio geographic classification.
- The Southern Ridge of Delhi, where in, the Asola – Bhatti WLS is located, is reported to have supported a low density, dry deciduous scrub forest & savanna vegetation comprising typical flora & fauna of North Western Arawalis, which was subsequently complemented by extensive plantations from as early as of British Era.
- The strategic location of this natural area is definitely going to prove to be an effective high potential carbon sink apart from very good sink for other pollutants, thus literally symbolizing as green lungs for densely populated and highly congested Delhi and other adjoining areas of Haryana.
- Being the seat of Transition Zone from Semi Arid to Gangetic Plains Bio-geographic zone, the entire Asola – Bhatti WLS could act as a an effective barrier against the advancing aridity from South West direction.
- The Sanctuary supports a significant population of Nilgai, Blackbuck, Foxes, Jackals, Mongoose, Porcupine, Jungle cat, Hare, Peafowl etc.
- It is conveniently accessed and ideally located to act as a centre for Biodiversity Conservation, Education & Nature Interpretation programme to spread the message of awareness about the nature & environment amongst nature lovers and school children.
- The sanctuary acts as thermo regulator by creating its own evapo-transpiration

regime.

- The deeply dug mining pits of the past, few of them are of gigantic dimensions act as stop over destinations for migratory birds;
- The sanctuary has greater role in underground water recharge and overall control of water regime.
- On attainment of fulfillment stage, the objectives can significantly contribute to cater the needs of aesthetic values and restore biological & ecological functions.

CHAPTER – 2

BACKGROUND INFORMATION AND ATTRIBUTES

2.1 Boundaries

The sanctuary has following boundaries.

North - Sangam Vihar, Durga Vihar colonies bordering Mehrauli - Badarpur Road.

South - Border with Haryana State.

East - Haryana interstate border & Road from Tughlakabad Fort to Suraj kund.

West - Asola, Fatehpur Beri & other villages of Delhi and Haryana state.

2.2 Geology, Rock & Soil

Asola-Bhatti WLS has a unique geological location. It is situated on the Western edge of Indo-Gangetic (Indus-Ganga) Plain and is the seat of transition between semi arid physiographic zone and northern plains physiographic zone. The Aravali Range is the oldest mountain range in India, running across Rajasthan from northeast to southwest direction, extending approximately 800 km. The northern end of the range continues as isolated hills and rocky ridges into Haryana, ending near Delhi. The Aravali Range is the eroded stub of an ancient fold mountain system. The range rose in a Precambrian event called the Aravali–Delhi orogen. The range joins two of the ancient segments that make up the Indian craton, the Marwar segment to the northwest of the range, and the Bundelkhand segment to the southeast. The terrain exposes quartzites, grits and schistose rocks, often ferruginous belonging to the Alwar group (lower part of Delhi basin rocks). The deeply dug pits created by extensive open mining in the area on the quartzites of the Alwar group and pegmatite veins which intrudes into it are used to be the source for various raw materials like China clay for pottery, terracotta for cottage industries and crushed quartzite and badarpur sand for the road and building construction sector.

The WLS falls in the Kohi or Pahari (hill side) physiographic division (Kalpavrisha, 1991), which represents rocky and undulating landform. The undulating terrain of the Wild Life Sanctuary is characterized by, the highest point being 320 meters above

MSL at Bhatti. The entire landform is split into various Nallahs and seasonal drainage channels and is extensively covered by exposed, irregularly distributed boulders of Precambrian, quartzite rock base. The rock outcrops are the northern most section of the Alwar formation and are found with several inter banded schist and phyllite. The quartzite is vitreous and coarsely crystalline in texture. Extensive weathering of these quartzite rocks yields high quality silica sand locally known as Badarpur or Bajri. The soil is thin, dry and sandy with high porosity and low humus status supporting sparse vegetation of scrubby nature.

Soil

Soil, the most important component of the land, performs to provide us food, fuel, fiber and shelter. However, the soil is deteriorating in its capacity of productivity due to natural and human induced degradation processes. Soil Degradation as the rate of adverse change in soil quality resulting in productive capacity of the land induced mainly by human interactions. Soil as a medium for plant growth should also be physically fertile. Soil consists of solids (Mineral and organic matter), liquid (Water) and gases (air) and is called three phase system. The physical, chemical and biological properties of a soil play an important role in determining its sustainability of supporting vegetative growth. For knowing the inherent potential of soil to sustain plant production in the mine areas of Asola – Bhatti, detailed preliminary survey has been carried out. In relation to soil parameters of the PA the following observations are given.

After surveying the Asola and Bhatti mine areas, 20 numbers of soil samples *i.e* 10 each from Asola and Bhatti mine areas were collected. Almost the mined area was degraded and rocky in nature so it was not possible to perform auger sampling and only surface samples were collected at 0-30 cm with the help of khurpi. The soil in the particular area lack greenery and prone to soil degradation by water and wind erosion most of the areas are barren with extrusion of rocks. Surface (0-30 cm) soil samples were obtained from these sites were air-dried, ground and sieved to pass through a 2 mm sieve. The processed soil samples were used to estimate some of the basic soil characters such as texture, bulk density, pH, EC, organic carbon, available nitrogen, phosphorous and potassium by using standard procedures.

Soil Texture and Bulk Density

As per the analysis, the soils are clayey loam (Asola mines) to sandy clay loam (Bhati mines) in texture. Soils of Asola mines are more clayey than soils of Bhatti mines. Generally soils rich in clay are sticky and easily become moulded as well as the pores between the clay particles are smaller so for water and air movement. These processes lead the formation of sub surface hard pans in Asola mines where as in Bhatti mine areas this hard pan formation was not much of problem. Bulk density of soil collected from Asola mine area varied from 1.28 to 1.72 gcm^{-3} where as for Bhatti mine soil it varied from 1.39 to 1.82 gcm^{-3}. This result showed that density of both the soils are high and indicate the low availability of organic carbon and have higher soil compaction. The bulk density of the soil can be used to give an indication of the porosity and structure of the soil which will, govern O_2 and H_2O movement in the soil.

Soil pH and Electrical conductivity (EC)

The soil pH was determined in 1:2.5, soil: water suspension with the help of combined electrode (Glass and Calomel) in a digital pH meter and results are presented in table No. 2.1 PH of the soil ranged from 7.56 to 8.22 in Asola and 8.22 to 8.49 in Bhatti area. Soils from both mined areas are salty in nature and come under saline soil pH range. Salty encrustation and more visible calcium canker nodules presence in soil might be the reason behind increase in soil salinity. The Electrical Conductivity of the soil was determined in the suspension liquid of soil water suspension used for measuring pH with the help of Conductivity Bridge. Soils of both Asola and Bhatti mine area recorded electrical conductivity (EC) of saturation extract more than 4 dSm^{-1} (4 mmho cm^{-1}). This phenomenon clearly indicates that the presence of neutral soluble salts in the soil is dominated by chlorides and sulphates.

Organic carbon content

Organic carbon content was determined in soil samples by passing through 100 mesh sieve by wet digestion method of Walkley and Black (1934) and results were expressed in percentage. Organic carbon content of soils collected from Asola mine area varied from 0.24 to 0.33 per cent with the average mean value of 0.30 per cent. Bhatti mine soils recorded 0.18 to 0.29 per cent organic carbon with the mean value of 0.23 per cent. In both the soils the organic carbon content was less which may be due

to poor vegetation and fast decay of organic matter in the particular area. Less organic carbon content in the soil may indicate that soil is more prone to erosion and other natural degradation because of lower binding capacity. Due to less vegetation cover in the mined area addition of organic matter through leaf litter and other residues is also less which may lead to poor organic matter build-up in these areas. Poor organic matter in soils may indicate a poorer environment for root growth; reduce in aeration and undesirable changes in hydrological function, such as reduced water infiltration.

Available Nutrients (Nitrogen, Phosphorous and Potassium)

The available nitrogen content of Asola mine soils ranged from 137 to 213 kg ha^{-1} with the average mean content of 163 kg ha^{-1}. As per critical nutrient concept the availability of nitrogen content in soil is low and may not support effective vegetation growth. The same trend of nitrogen content was observed in soils collected from Bhatti mine area with the mean value of 151 kg nitrogen per hectare. Nitrogen plays a vital role in plant growth and development; deficiency may produce weaker and slender plants which will lead to more mortality in plants. Soils collected from Asola and Bhatti mine areas were recorded available Phosphorus in the range of 11.6 to 20.1 and 12.8 and 18.9 kg ha^{-1}, respectively. The result indicated that the soils collected from these areas are low in available phosphorous content. The role of phosphorous in plant helps to improve in root growth, seed germination, fruit setting and shoot development. All these process will be affected due to its low availability. The available potassium content in soil was medium in range and it was averaged 117 kg ha^{-1} in case of Asola soils and 110 kg ha^{-1} in Bhatti soils.

Table 2.1: Results of Soil Analysis

Sample No	pH	Ec dsm^{-1}	Bulk Density (gcm^{-3})	Organic carbon (%)	Available Nitrogen ($Kgha^{-1}$)	Available Phosphorous ($Kgha^{-1}$)	Available Potassium ($Kgha^{-1}$)
Asola Mines							
1	7.62	4.586	1.68	0.28	176	19.2	118
2	7.86	4.324	1.72	0.24	213	18.6	96
3	7.56	4.186	1.56	0.28	159	15.4	106
4	7.82	4.637	1.28	0.29	142	12.6	128
5	7.96	4.828	1.36	0.32	168	13.5	129
6	8.06	4.946	1.58	0.33	179	11.6	136
7	7.76	4.226	1.62	0.36	147	17.9	110

8	7.87	5.182	1.54	0.27	158	16.3	108
9	8.08	4.981	1.49	0.29	137	20.1	119
10	8.22	4.732	1.70	0.32	155	19.6	128
Mean	7.88	4.663	1.55	0.30	163	16.48	117
Bhatti Mines							
11	7.96	4.870	1.67	0.29	158	17.4	106
12	7.83	4.556	1.82	0.21	149	16.5	94
13	7.98	4.820	1.72	0.18	158	18.9	106
14	7.99	4.117	1.58	0.21	139	17.6	127
15	8.26	4.328	1.47	0.26	152	14.4	116
16	8.38	4.883	1.39	0.29	139	18.2	106
17	8.46	4.767	1.43	0.25	178	17.6	97
18	8.33	4.802	1.49	0.23	130	18.3	103
19	8.17	4.967	1.58	0.19	128	16.4	126
20	8.49	4.877	1.69	0.22	176	12.8	119
Mean	8.18	4.699	1.58	0.23	151	16.8	110

2.3 Terrain

The terrain of the WLS is undulating hilly. The slopes are mild with low soil depths. Rocky outcrops are the common feature.

2.4 Climate

It is characterized by humid tropical weather. Winter are dry and relatively short. They also tend to be foggy. Summers tend to be long and very hot, with high temperatures sometimes exceeding 40°C. They also tend to be extremely dry and dust followed by the monsoons, where the region experiences heavy rain on a daily basis. Average high temperatures decreases during the monsoon season but the humidity increases. This results in hot and humid conditions.

Climate of Asola-Bhatti Wildlife Sanctuary is mainly influenced by its remote inland position and prevalence of air of continental character, which is characterized by extreme summer heat alternating with great winter cold. The climate is of semi-arid nature due to marked diurnal differences of temperature, high saturation deficit and moderately low rainfall. The desert area in west and south-west and the Gangetic Plains in east, across which the monsoon air travels and reaches Delhi, have their respective shares in affecting the climate of wildlife sanctuary. Extreme dryness with an intensively hot summers and acute sweep of air from westerly or north-westerly directions, while influx of air from easterly or south –easterly usually causes increased humidity, cloudiness and precipitation. The climate is markedly periodic and is

characterized by dry and increasingly hot season from March to June, dry and cold winter from October to February and humid warm, monsoon period from July to September.

2.4.1 Rainfall Pattern and distribution

The arrival of south-west monsoon in this area is regarded as a meteorological event of considerable importance. The total annual average rainfall is 665.30 mm. The highest rainfall generally occurs in the month of July followed by August. The wettest period of the year is the last week of July. Nearly 80% of the normal annual rainfall is recorded during middle of June to middle of September. Considering the year as a whole, 90% of days are rainless. The monthly distribution varying from maximum number in October and November to the minimum number in July and August. The month of November is driest. As a result of uncontrolled grazing and deforestation, rain has caused extensive soil erosion. Depressions and deep ravines have been formed on the hill slopes of wildlife sanctuary near Mehrauli. Monthly rainfall data of last five year is enclosed at Annexure- III

2.4.2 Temperature; a summary of year round pattern

One of the most characteristic features of climate of Asola-Bhatti wildlife sanctuary is the great extremes of temperature. The heat during the summer is intense and the temperature goes up as high as 46° C during the month of June. On the other hand, the cold during winter i.e. from December to February is severe and the temperature goes as low as -0.6° C. January is the coldest month of the year. In this month the mean maximum and mean minimum temperature are lowest being 21.7° C and 6.1° C respectively. Moreover, in the end of January due winter disturbances, the temperature sometimes reaches the freezing point. The month of the February is slightly warmer and temperature starts rising by the middle of March. Hot season prevails during the period of April to June. The monthly mean temperature is highest during June when the night temperature is also at its maximum, although the day temperature is lowest in May. Monthly temperature data of last five year is enclosed at Annexure- IV

2.4.3 Relative Humidity; a summary of year round pattern

Relative humidity is very low in the dry weather months of April and May whereas it is high during the monsoon months of July, August and September. Season wise,

relative humidity during cold season from December to February is generally 61-71% in morning hours and 31-38% in afternoon hours. The higher mean values in June are due to the rains that occur towards the end of month with the onset of the monsoon. The air is quite dry during the pre-monsoon season and in afternoon hours humidity values approach 10%. In rainy season from July to September there is marked rise in humidity showing maximum of 80% in the morning and 61% in the afternoon. The variation of relative humidity during the day is 30-36% in winters, 19-27% in summer and 19-30% in monsoon months. The periods of high relative humidity are optimum for vegetation growth.

2.4.4 Wind speed; a summary of year round pattern

For most of the year, wind is mild with the mean velocity of 0.9- 2 m/s. Taking the year as a whole, the prevailing direction of wind during September to May is from west to north-west. The percentage of winds with westerly components is quite large during the rest of year; easterly components predominate, particularly during the months of active monsoon. Wind is strongest in June and lightest in November. In the summer months, hot and dust raising winds (Loo) are commonly experienced and result in thunder-storms/Dusts-storms. Thunder storms form an important climatic feature in Delhi, though they may occur any time of the year, normally are faced during May to August. The dust-laden high winds during the summers aided by high temperature and low humidity exert depleting and desiccating influence over the vegetation. Occasionally the dust storms are followed by powerful squalls which may be very turbulent and air so charged with dust that it brings about an Egyptian darkness irrespective of the hour of the day (Naithani *et.al* 2007).

2.5 Water Sources

Due to the predominantly sandy nature of the soil, the surface runoff is low and rain water quickly seeps down and gets trapped in the underlying rocks. The water table depth varies from 35-50 m in Bhatti. The ground water is used for irrigation and drinking purposes in the plains and flat areas lying in the vicinity of the wildlife sanctuary. The district Gazetteer of Delhi (1883-84) records that in the latter part of 18th Century the best drinking water was obtained from springs in the Ridge. There is little evidence that these springs still exist, which reflects grave status of degradation.

Apart from the main water body located in Asola on Haryana Border locally known as *Pani Wala Khan* which is the largest perennial water source in the PA and other Jatonwalla Johar - located in the south-western part of the sanctuary. There are about 31 other water sources in all including tube wells both in Asola & Bhatti areas with availability of water for 3 to 12 months.

2.6 Range of Wildlife, Status Distribution and Habitat

2.6.1 Status of Vegetation

2.6.1.1 The Bio-geographic Classification

The Wildlife sanctuary though occupies 4A Semi Arid Punjab plains category of Rodger's & Panwar's biogeographic classification is the seat of transition from Semi Arid category to Upper Gangetic Plains category. The 230 mtr contour line of the ridge is the western boundary of the Gangetic plain (study report WII, 1996).

Biogeographically the Aravali Hill range represents one of the ancient landforms of India. Approximately 800 kms long, this range originate in Rajasthan and extend northeastward across Haryana. The Mewat branch of Aravalis enters Gurgaon from the south and terminates in Delhi in the form of a tableland, creating a transitionary zone between the Aravalis and the Indo-Gangetic plain. Sixteen Kms. South of the city of Delhi, the range splits, with one branch turning backwards to re-enter Gurgaon thus forming a crescent and the other continuing northeastward bisecting Delhi. These disjointed narrow hillocks are collectively referred to as the Delhi Ridge which has been officially divided into four zones. The Northern or the old Delhi Ridge, 87 ha in extent, lies on the west bank of Yamuna between Civil Lines and the University of Delhi. It is the smallest section of the Ridge. The Central or New Delhi Ridge, comprising 864 ha lies north of Dhaula Kuan. These two sections have received administrative attention since 1878 and have been collectively developed as the 'green lungs' of Delhi by raising plantations of native and exotic trees. (Chopra P.1976, Centre for Inter-Disciplinary Studies of Mountain & Hill Environment, University of Delhi 1993).

The South-Central Ridge, 4266 ha in extent, lies in Mehrauli while outside the city limits to the south lies the Southern Ridge, 6200 ha in extent. The Southern Ridge appears like a crescent which starts from the east from Badarpur along the Haryana State limits and joins the Mehrauli-Mahipalpur road near Sultangarh tomb.

The Asola Bhatti Wildlife Sanctuaries are located in the south eastern part of the Southern Ridge.

2.6.1.2 The Forest Types, Cover and Food for Wild Animals

As per champion & Seth (1968), the vegetation falls under Northern Tropical Thorn Forests type (6B/C). The vegetation in the wildlife sanctuary is predominantly an open canopied thorny scrub. The vegetation presents a very open appearance so that the trees and shrubs are widely spaced. The bulk of the vegetation consists of co dominant, spinous shrubs & trees, capable of great drought resistance. The native plants exhibit xerophytic adaptations such as thorny appendages, wax coated, succulent and tomentose leaves with thick cuticle and protected stomata. Most of the woody species regenerate vegetatively by throwing out root suckers and coppicing shoots and some propagate even by natural layering. The trees comprising the perennial vegetation of the sanctuary of the ridge are both indigenous and introduced. The indigenous species includes *Prosopis cineraria* (linn.)Macbr. *Acacia Leucophloea* Willd., *A. modesta* Wall., *A. Senegal* Willd., *A. nilotica* ssp. *indica* (Benth.)Brenan, *A. Catechu* Willd., *Butea monosperma* (lamk.) Taub., *Anogeissus pendula* Edgew., *Salvadora oleoides* Decne., *Wrightia tintoria* R. Br., *Cordia dichotoma* Forst.f., *C. Gharaf* (Forsk.), *Ehretia laevis* Roxb., *Tecomella undulata* (Sm.) and *Balanites aegyptiaca* (Linn.). Among the introduced species , the most noteworthy is *Prosopis juliflora* DC., Other successful introduced trees are *Azadirachta indica* Juss., whose self sown seedlings are common, *Feronia limonia*, *Dalbergia sissoo* Roxb., *Parkinsonia aculeata* Linn., *Cassia fistula* Linn.,

Albizia lebbeck Benth., *A. amara* Boiv., *Mitragyna parvifolia* Korth., *Holoptelea integrifolia* Planch. and *Prosopis glandulosa* Torr. Among the shurbs, *Jatropa gossypifolia* Linn., native of Brazil, and *Opuntia elatior* Mill., native of South America, have become naturalized on the Ridge.

The thorny shrubs occur in widely spaced clumps supporting a number of runners and climbers. Of these *Capparis separia* Linn, is very common and abundant, growing alone or associated with *Grewia tenax, Securinega leucopyrus, Carissa opaca, Flacourtia indica, Maytenus senegalensis, Clerodendrum phlomidis, Capparis*

decidua. Other shrubs met in localized, isolated patches include *Dichrostachys cinerea* Wt. & Arn., *Mimosa hamara* Willd. and *Diospyrus montana*

A. **Trees**

Acacia Leucophloea (Ronj), Acacia nilotica ssp. indica (Babul), Anogeissus pendula (Dhoy, Sira), Azadirachta indica (Neem), Butea monosperma (Dhak), Balanities aegyptiaca (Hingota), *Dalbergia sissoo (Shisham), Diospyros cordifolia (Tendu), Ficus religiosa* (Peepal), *Holoptelea integrifolia (Churail papdi, kangu), Morus indica* (Toot), *Pongamia pinnata (Papdi), Prosopis juliflora (Vilayati babul), Tamarix indica , Wrightia arborea, Wrightia tintora (Durli), Ficus bengalensis(Bargad), Tecomella undulate*

B. **Shrubs**

Capparis separia(Heens), Grewia tenax (Ram Channa), Securinega leucopyrus, Carissa opaca (Karoda), Flacourtia indica (Khattai), *Maytenus senegalensis (Kakera), Clerodendrum phlomidis, Capparis decidua, Dichrostachys cinerea, Lantana camara, Flueggea virosa, Zizyphus nummularia (Jhad, Beri), Pavonia zeylanica, Solonum incanum, Xanthium indicum (Bitchu), Securinega virosa, Plumbago zeylanica (Chitrak), Hibiscus ovalifolius, Ricinus comminus, Calotrpis procera, Asparagus racemosus (Satavari)*

C. Herbs

Achyranthus aspera (Lath zeera, Apamarg), *Vernonia cininea, Blepharis maderaspatensis, Boerhavia diffusa, Evolvulus alsiniodes, Peristrophe paniculata, Tephrosia purpurea, Tridex procumbens, Cassia tora, Sida cordata, Parthenium hysterophorus, Triumfetta rhomboidea, Aerva sanguinolanta, Physalis minima, Blumea laccrea, Ageratum conyzoides, Argemone mexicana, Cassia occidentalis, Borreria articularis, Dicleptera macrintha, Corchorus aestuans, Commelina bengalensis, Amaranthus virdis, Euphorbia hirta, Solonum nigrum, Anisomeles indica, Elytraria acaulis, Indigofarra linnaei, Withania somnifera, Aerva scandens, Alysicarpus vaginalis, Pupalia lappacea, Peristrophe bicalyculata, Blumea mollis, Dipteracanthus suffruticosa, Commelina forskalali, Solomun surattense,*

Corchorus olitorius, Sida rhombifolia, Dipteracanthu spatulas, Ocimum americanum

D. Climbers

Pupalia lappacea, Ipomoea eriocarpa, Cissampelos pariera, Ziziphus oenoplia, Jasminum mutiflorum, Ipomoea sinensis, Mukia maderaspatana, Rhynchosia minima, Ipomoea pes-tigridis, Cocculus pendula, Pentatropis spiralis, Tinospora cordifolia (Gulel, Geloh), Cordiospermum halicacabum, Oxystelma secamone (Doodhlata, Makhaubel)

E. Grasses, Bamboos & Hedges

Heteropogon contortus, Digitaria ciliaris, Brachiaria ramose, Bothrichlora pertusa, Cenchrus ciliaris, Sporobolus diander, Dactyloctenium aegyptium, Alloteropsis cimicina, Desmostachya bipinnata, Eragrostis poaeoides, Saccharum spontaneum and *Vitiveria zizanioides, Eragostis tenella, Eragostis ciliaris, Dendrocalamus strictus, Chloris dolichostachya, Saccharum benglense, Cynodon dacylon, Eragostis viscoa, Phygramites, Setaria verticilata, Setaria pumila, Erigrostiella bifaria, Oplismenus burmanii, Cyperus triceps, Cyperus compressus*

Forest type is a part of Management Plan data collection through vegetational analysis of Asola Bhatti WLS was conducted by Dr. H.B.Naithani. The detailed vegetation report is enclosed at Annexure. The area is fully covered with top canopy of *Prosopis juliflora*. All the pits and their slopes are thickly covered with trees, shrubs & grasses in Bhatti area and it is difficult to make out that the crop in Bhatti area is younger by 4 to 8 years than the Asola area. Canopy density in Bhatti area including the mines is considerably high due to less disturbance as a sequel to presence of ETF in part of that area. The only large herbivore is Nilgai (*Boselaphus tragocamelus*) in fairly good numbers which is both grazer & browser. Despite tough competition with domestic cattle grazing in most of the area, the health of Nilgai is very good. Pea fowls (*Pavo cristatus*) are found in good numbers and were encountered everywhere. They too have enough food material. Other animals are hares, mongoose, porcupines, Jackals, civets and some small cats. Mongoose can be encountered in any part of the sanctuary. There are two deer enclosures of 100 ha each with a population of 26

Cheetal (*Axis axis*) & 26 Black bucks (*Antilope cervicapra*) in each which came up after last management plan. Their management etc will be dealt in the main management plan.

2.6.1.3 Species and Communities of Conservation Importance; Key Areas.

Continued large scale mining of quartzite based badarpur sand left the entire area of notified Asola Bhatti on the brink of, completely devoid of vegetation. The floral history of the area boasts good vegetative cover comprising various Acacia species such as *A. nilotica, A. leucophloea, A. catechu* and *A. modesta* with good interspersing patches of *Butea monosperma, Cassia fistula, Salvadora persica, Anogeissus pendula* and *Albizzia lebbeck.* After declaration of the wild life sanctuary all mining activities were closed. A 41 km long rubble and concrete protection wall around the sanctuary was erected to forbid grazing and biomass collection. It is observed that the protection measure by way of closure of the area for external pressures started showing signs of initiating the recovery. To expedite the process of developing green cover, aerial sowing of *Prosopis juliflora* has been carried out on blank patches. The abandoned mining sites bore the look of barren and dry areas honeycombed with deeply dug pits and *kucha* roads. A thorough look into these sites after a span of more than a decade indicates the rich biological ability of the area. The return of native species and encouraging results of aerial sowing helped in establishing a good green cover, thereby contributing addition of humus, nutrients and nitrogen to the soil. The abandoned pits now turned into good perennial water bodies. Presence of water in these pits throughout the year clearly indicates the increasing level of water table.

Evidently the improving trend of ground water recharge can be attributed to closure of mining activities in Delhi as well as in Haryana areas. As a result of extensive seeding *Prosopis juliflora* has formed a complete canopy and in many areas thick closed canopies of the same can be seen. *Zizyphus nummularia* is found to be one of the abundant species in the area despite being subjected to extensive browsing. *Prosopis juliflora* is found to be invading especially in the basin of large pits of Bhatti area leaving little or no room for other species to come up. The exposed slopes and crevices on the vertical surfaces of the mining pits are found to be getting well vegetated with Neem, Ficus species, Shisham etc. Areas under *Prosopis* vegetation have shown significantly very less ground cover than the areas under next most abundant tree species like *Acacia leucophloea* or associations of *Butea monosperma.*

In a wilderness area so close to the NCT of Delhi every bit of the PA is a key area as far as its value to the citizens of Delhi goes. Every species of flora and fauna is of conservation importance in this only representative PA of Delhi Ridge which is transitionary zone between the ancient Aravalis and the Indo Gangetic plains. The biological value and ecological functions of these PAs is immense and calls for far more attention on the part of the Govt of NCT of Delhi and also the Ministry of Environment & forests Govt. of India. To restore it fully and manage it in such an intensive manner that it can present a model for all other metropolis. The presence of Eco Task Force in the Bhatti WLS for the last 10 years with their efforts to restore the greenery of the area and to extend their area of operation in other part of Asola WLS is an indication of the seriousness on the part of State and Central Governments. Their presence also indirectly serves as deterrent to trespassers & encroachers.

2.6.2 Animals

The sanctuary and neighbouring ridge Forest are abode of variety of mammalian, birds, amphibians, insects etc. The detailed list is enclosed from annexure VI to IX. Some of the prominent and most common ones among them are mentioned below.

2.6.2.1 Vertebrates, their status, distribution and habitats, Habitat quality, quantity and key areas

Mammals: Sinha and Sati (1997), in a recent publication- the Fauna of Delhi have reviewed the studies so far done on mammals of Delhi. Kalpvriksh(1991) reported 29 species of mammals from the ridge area. Zoological survey of India Dehradun(1996-1999) has reported the presence of 18 species of Mammals belonging to 10 families and 7 orders in the Sanctuary area. The detailed mammalian list is enclosed at Annexure VI

The main herbivores of the sanctuary are Blue bull/nilgai (*Boselaphus tragocamellus*, Black buck (*Antilope cervicarpa*), Porcupine (*Hystrix indica*), *Rhesus macaque* (*Macaca mulatta*), Hanuman langur (*Presbytis entellus)*, Common hare (*Lepus nigricollis*). Among the carnivore Jackal (*Canis aureas*), Jungle cat (*Felis chaus*) are found. Presence of Hyaena(*Canis hyaena*) is also reported. The other species found in the area are Palm Squirrel (*Funambulus pennantii*), Small Indian civet (*Viverricula indica*), Small Indian Mongoose (*Herpestes javanicus*). Indian Grey Mongoose(*Herpestes edwardsii*) Indian pangolin(*Manis crassicaudata).*

Birds: Approx. 82 species of birds are reported from WLS & neighbouring ridge forest areas (Tak, P.C. & Sati J.P., 2003) Out of 82 species, 56 are resident, 16 migrant and 6 resident/migrant and 4 lacking information of their status, Species such as pond heron, little egret, hoopoe, house crow, red vented bulbul, robin, white wagtail etc. are common resident birds. Common migratory birds are sand piper, rosy, starlings, rock pipit, grey wagtail, white wagtail etc. Indian Peafowl (*Pavo cristatus)* (the national bird) the only threatened bird is observed in the sanctuary. The detailed bird list is enclosed at Annexure VII

Reptiles: Reptilian survey seems to be lacking for the sanctuary areas. Zoological survey of India Dehradun(1996-1999) has reported the presence of one species of snake and four species of lizards.The common snake species found is Slender Work Snake(*Typhlops porrctus*). Four species of lizards Garden Lizard(*Calotes versicolar*), Spotted Brooks Gecko(*Hemidactylus brooki)*, Snake Eyed Lacerta(*Ophisops feidoni*), Striped Kink(*Riopa punctata*) have been reported. The detailed list is enclosed at Annexure VIII

Amphibians: The recent amphibian survey available for the sanctuary area is by Zoological Survey of India by Akhlaq Husain. Five amphibian species like Common toad(*Bufo melanostictus*), Marbled toad(*Bufo stomaticus*), Ornate frog(*Microhyla ornate*), Skipping frog(*Rana cyanophlyctis*), Cricket frog(*Rana limnocharis*)are reported. The detailed list is enclosed at Annexure IX

Fishes: Three species of fishes Spot-fin Carb *(Puntius sophore),* Brown snake head *(Ophiocephalus gachua)* and Mosquito fish *(Gambusia affinis)* are reported from sanctuary area (Hussain, 2003).

Lepidoptera:- The recent survey data available for the sanctuary area is by Zoological Survey of India Dehradun by Pramod Kumar and S.K Gupta. The systematic account deals with 25 species of butterflies under 5 families. The detailed list is enclosed at Annexure X.

2.6.2.2 Wild animal population estimation of main species

Relative abundance of ungulates (Nilgai), livestock (Cow, Goat and camel) and other wildlife (Golden jackal, Peafowl, Hare and Rhesus macaque) is estimated. Based on the direct individual sighting and indirect sightings (Scat/dung/pellet).

We calculate encounter rate and mean group size of animal sightings was calculated. All the calculations were conducted using formulae as mentioned below. Mean

encounter rate of pellets and group size was also calculated for each of the animals observed on transects. The results for each of the species are provided in the Table 2.2.

Direct sightings

Mean encounter rate (Individuals/km) = No. of individuals observed/ Total length of the transects

Mean group size (Number of individuals per group) = Sum of all the observations/ Number of observations

Indirect sightings

Mean encounter rate (Scat/Pellet/Dung) = Sum of all observations/Total length of the transect

Mean group size (Scat/Pellet/Dung) = Sum of all the observations/ Number of observations

Table 2.2: Mean encounter rates and group size of direct and indirect signs of Nilgai, Peafowl and Hare

Species	Direct sighting		Indirect sighting (Scat/Pellet/Dung)	
	Encounter rate (± SE)	Group size	Encounter rate (± SE)	Group size
Nilgai	2.45 (±0.65)	2.29	5755.5 (± 52.8)	380.9
Golden Jackal	0.25 (± 0.33)	1.13	1.12 (± 0.10)	1.2
Peafowl	2.01(± 0.27)	1.18	3.0 (± 0.19)	1.4
Hare	0.06	1.0	20.08	36.8

Disturbance by domestic cattle

There is large scale grazing and browsing in the WLS by domestic cattle. This was estimated along with estimation of wild animals the result is as under-

Table 2.3: Disturbance by domestic cattle

Species	Direct sighting		Indirect sighting (Scat/Pellet/Dung)	
	Encounter rate (± SE)	Group size	Encounter rate (± SE)	Group size
Goat	1.88 (± 9)	15.0	214.7 (± 4.1)	34.2
Cow	1.57 (± 2.39)	5.0	24.7 (± 0.18)	2.4
Camel	*	*	72.2 (± 4.53)	20.9

* No observation was recorded in this category

2.6.2.3 The Limiting factors:

During summer water seems to be limiting factor for wildlife of the sanctuary. Due to sandy nature rain water percolates underground.

2.6.2.4 Invertebrates, their distribution, status and habitats:

Wide variety of butterflies, moth, insects and mollusc are in abundance. There are approx. 25 species of butterflies identified in the WLS and neighbouring ridge. The list of other invertebrates like Mollusc, Arthopoda, is enclosed as Annexure.....

2.6.2.5 Species of conservation priorities:

Every species of flora and fauna is of conservation importance as the ecological value of WLS is immense. Hence no prioritisation of conservation value for some species is felt necessary during the present Management Plan period.

2.6.2.6 Threats to wildlife and their Habitats in the Sanctuary:

Use of Biomass by people: The villagers settled around the Asola and Bhatti WLS are largely dependent upon forest bio-mass for fuel and cattle grazing. Asola WLS, after notification, was fortified by rubble wall of 41 km in length, protecting the sanctuary against grazing and illicit cutting of wood. However the wall has been breached at many places. Important palatable species are under over utilization due to domestic live stocks like cow, goat, sheep etc.

Water: Shortage of drinking water is faced in nearby villages. It is reported that some water holes were also developed in WLS for providing water to wildlife. But most of them do not retain water and few others barely make it through the summer. The accessible water is mostly used by wandering herds of cattle, goat and sheep.

Tresspass and thoroughfare: Vehicular traffic has significantly reduced after ban of mining activities. However, still use of roads in the WLS is in practice. Although the Forest Department has put up barriers on the Delhi side entry point, its effectiveness is questionable due to inadequate administrative infrastructure and absence of acceptable alternative road linkages.

Stray Cattle: Nearby villagers dump their unproductive cattle in the WLS. These

cattle over utilize the biomass, thus chance of recovery of eco-system is undermined.

Dumping of waste: In some fringe areas of WLS all kinds of non-biodegradable and biodegradable rubbish is dumped in and outside the rim of pits.

Settlements: Three colonies Sanjay Nagar, Balbir Nagar and Indira Nagar are located inside the sanctuary. Five villages namely Satbari, Sahurpur, Maidangarhi in west, Deoli village in North West and Sujarkund in the south are located on the fringe of WLS. The human and cattle population is increasing which will pose more threats.

Release of Monkey inside WLS: Unmanageable *Rhesus macaque* population in the capital region is captured and released in WLS area. Till January 2015, 18,507 numbers of monkeys were released inside WLS by various agencies like Forest Dept., NDMC and MCD.

2.7 Vegetation Cover/ Land Use Mapping

Assessment of vegetation cover/ land use was carried out using satellite imagery and Google earth as a validation source for land use mapping.

The various vegetation cover/land use existing in the study area is shown in Fig. 2.1 and 2.2. These vegetation cover /land use is divided into 8 classes. Table 5.1 shows the area under different vegetation cover/land use types. *Prosopis juliflora* was found to be the dominant vegetation covering an area of 71.62 percent (23.42 km^2) followed by scrub with an area of 12.04 percent (3.9 km^2). *Anogeissus pendula*, which was found as a patch or sparsely distributed in various locations within the entire sanctuary, having an area of 0.29 percent (0.094 km^2).

Forest plantation, in action under progress by Eco Task Force (ETF), being covered an area of 4.01 percent (1.31 km^2) of entire sanctuary. 7.93 percent (2.59 km^2) area was classified as non-forest type, because it was not found to be having any vegetation because of the human disturbance in that area. Rocky outcrops are found in south-eastern region in the form of hills which are extension of Arawali hills, having an area of 1.03 percent (0.34 km^2). The study area was found to be covered by 0.16 percent (0.05 km^2) area of water body while 2.92 percent (0.96 km^2) area being is covered by settlements.

Table 2.4: Area (%) under different vegetation cover/land use types

S.No.	Land use type	Area (km2)	Area (%)
1	*Prosopis juliflora*	23.43	**71.62**
2	*Anogeissus pendula*	0.09	**0.29**
3	Forest plantation	1.31	**4.01**
4	Scrub	3.94	**12.04**
5	Non-forest	2.59	**7.93**
6	Rock outcrop	0.34	**1.03**
7	Water body	0.05	**0.16**
8	Settlement	0.96	**2.92**
Total		32.71	**100.00**

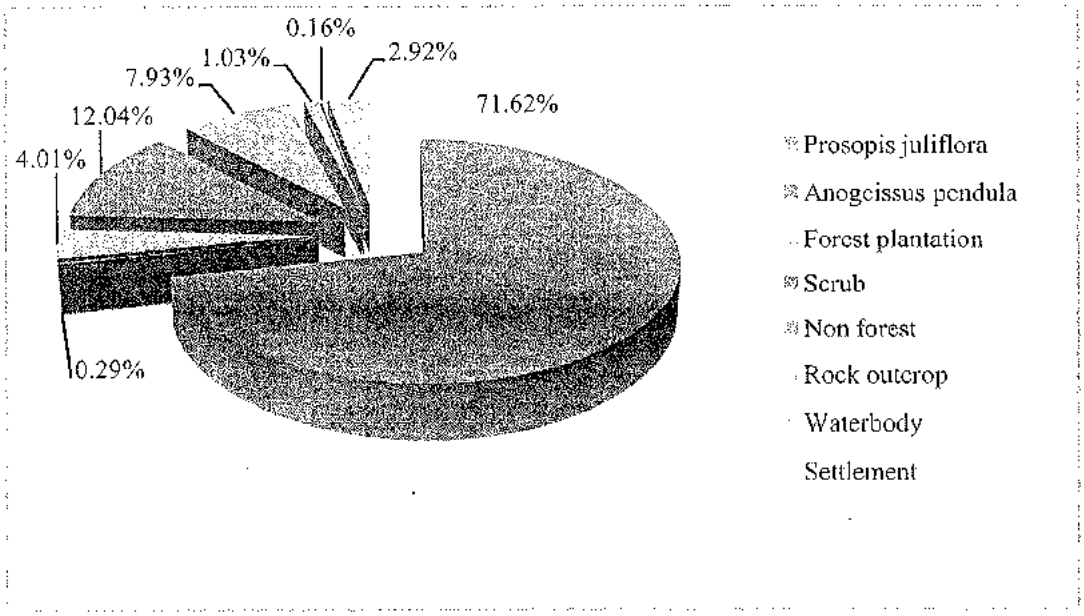


Fig.2.1: Area (%) under different classes of vegetation cover/land use map

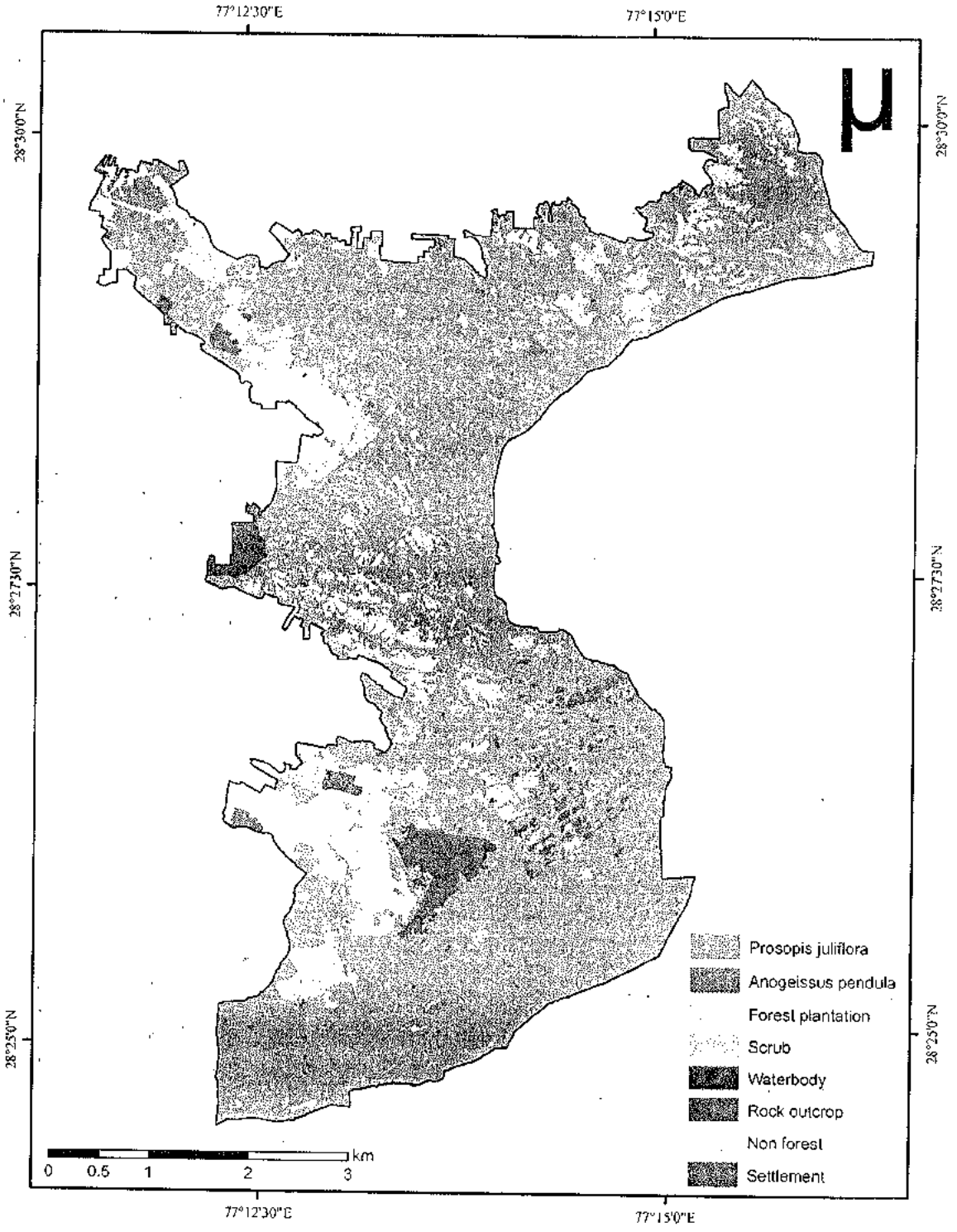


Fig.2.2 : Vegetation cover/land use map.

2.8 Forest density mapping

With the help and technical guidance of DR. Kushwaha of IIRS Remote Sensing Institute Dehradun IRS P6 LISS-IV MX and Cartosat-1 PAN merged imagery were visually interpreted to delineate the crown density map of the study area depending on the visual interpretation considering the various interpretation keys like tone, texture and pattern.

Forest density was divided into three classes i.e. 10-40% as low density, 40-70% as moderate density and more than 70% as high density. Forest density map existing in the study area is shown in Fig. 5.3 and 5.4. Out of 32.71 km2 of total area, only 7.70 percent (2.51 km2) area was categorized under high density class i.e. above 70 percent. Moderate density covering an area of 16.22 percent (5.30 km2) of the study area i.e. 40-70%, while half of the (17.00km2) area of the entire sanctuary was categorized as low density forest (52.00 percent) Scrub, rocky outcrop, water body, non-forest and settlement classes rest area of sanctuary The unauthorized settlements were formed to be consisted the most disturbing factor as there was major degradation of forest around these areas.

2.9 Habitat suitability map

Habitat suitability map for nilgai using AHP technique was developed. The map developed is enclosed at Map VIII at part III(A) of the management plan. Various factors taken into consideration while developing through AHO model are forest density, forest type, water body, slope, settlement, road and drainage.

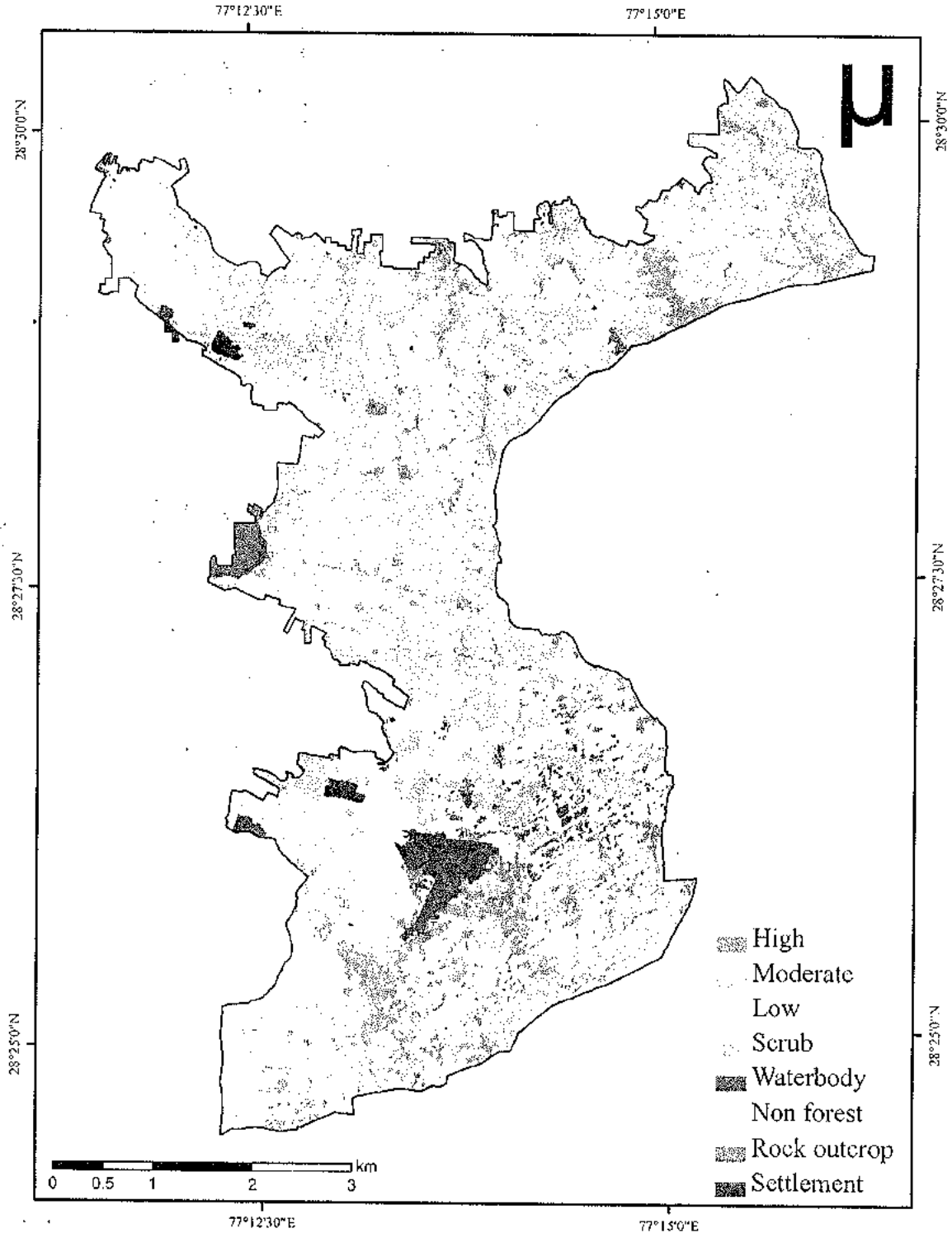


Fig. 2.3 Forest Density Map

Table 2.5 : Forest density (%) of different classes.

Sl.No.	Density class	Area(Km2)	Area(%)
1	High	2.517938	**7.70**
2	Moderate	5.307181	**16.22**
3	Low	17.00931	**52.00**
4	Scrub	3.9392	**12.04**
5	Rock outcrop	0.33635	**1.03**
6	Waterbody	0.052238	**0.16**
7	Non-forest	2.594125	**7.93**
8	Settlement	0.956713	**2.92**
	Total	32.71306	**100**

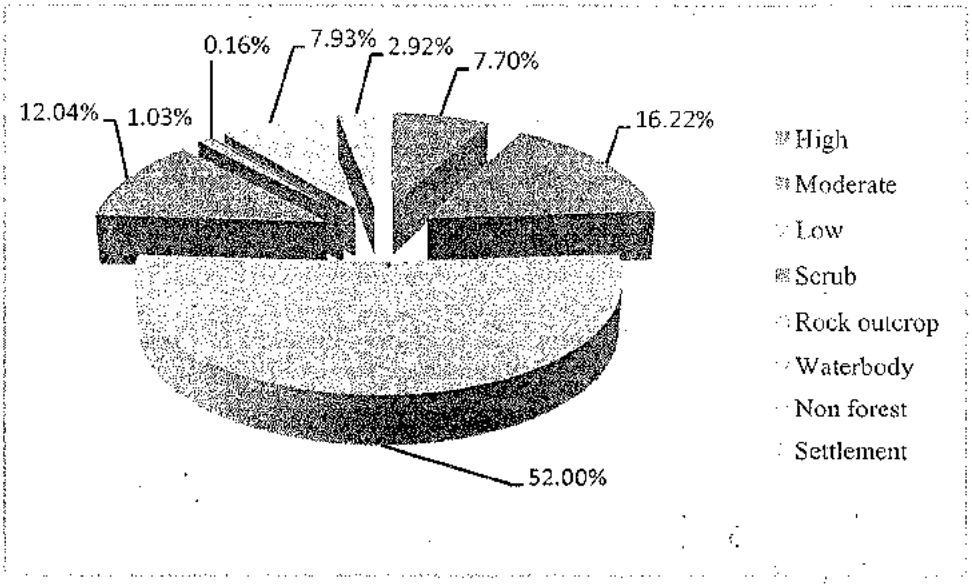


Fig.2.4: Area (%) under different classes of forest density.

CHAPTER – 3

HISTORY OF MANAGEMENT AND PRESENT PRACTICES

3.1 General

Asola WLS came into existence after notification to sanctuary status (4707 acres) after 1986 whereas Bhatti WLS (area 2107 acres) was notified in 1991. Both Asola and Bhatti WLSs fall within Southern Ridge and are contiguous to each other. For convenience it is referred as Asola- Bhatti WLS. Bhatti Mines are located on the South-Eastern part of Delhi-Haryana border and from part of the Arawali ranges. Documented history reveals that this area was densely forested till 1900 AD. The abundance of "Mineralise Quartz" or "Bajree"/Badarpur found in this part of Aravali made it an attractive mining area. Due to large scale construction activity in and around Delhi and consequent requirement of bajree and stone, the area turned into illegal mining heaven and stone quarries. As term leases were granted, during 50-60 years of mining, there was total destruction of the flora and fauna in the area. The soil also got degraded, water table went down and rainfall also got reduced in Delhi. Assessing the gravity of the situation, the Government of Delhi in a visionary step completely banned mining. Despite Bhatti Ridge having being designated as Wild Life Sanctuary mining continued unabated.

With the aim of protection, some parts of the Southern Ridge have been converted into a Sanctuary and in fact this is the only sanctuary in NCT region which has been created through innovative measures. When mining was closed in 1991 about 200 pits of various sizes, honey combing the area, were left open by various operators. The pits are irregularly distributed. Soil excavation sites vary in size, the smallest being about 20-30 m deep with surface cut of about 25 to 50 m across. Some pits like pit No. 2 and 12 have much larger dimensions.

The area was adversely affected by the mining activities undergoing on Haryana side all along the boundary of Sanctuary. In the pits of Sanctuary there was no perennial water. In 2002 the mining in Haryana has been stopped by the Hon'ble Superme Court of India. As a result of ban on mining the water label has now increased in the abandoned pits of sanctuary area particularly in pit No. 9.

3.2 Timber operation including bamboo & fire wood harvest

3.2.1 Silvicultural system & Tending Operation

No Silvicultural or tending operation was practiced in this area except protection from felling.

3.2.2 Evenaged System & Unevenaged Systems

The sanctuary is conserved in situ. No other forestry activity is done except restoration of vegetation. The vegetation is open canopied thorn scrub forest with uneven aged system.

3.2.3 Bamboo Working

Dendrocalmus strictus bamboo is found in isolated parts of WLS. No bamboo working practiced in the WLS area.

3.2.4 Firewood Harvest & Collection

Villagers from Sanjay colony, Indira Colony and Balbir Colony carry out illegal collections of firewood. However no prescription for firewood collection exists.

3.3 Non Wood Forest Produces (NWFP) Collection

Since the legal status is protected area no collection of NWFP is allowed. NWFP collection by neighbouring people is absent as there are hardly any NWFP present in the Sanctuary due to heavy grazing and removal of firewood.

3.4 Leases

No lease of land inside sanctuary exists.

3.5 Other programmes and Activities

Some of the activities taken up during last few years are eco-restoration, re-settlement of villages and development of interpretation centre etc.

3.5.1 Management planning for Asola- Bhatti WLS by WII

The prescription of the last Management plan prepared by WII remains to be followed even now. The objective of the previous Management plan still remains to be attained except that the restoration of highly impacted habitat has been achieved to a

considerable extent. The area now gives a look of a green patch of forest and the scarred mine pits of Bhatti area present a look of canyon like topography full of greenery at the bottom and lower slopes of pits. Because of undisturbed habitat in these pits the restoration process has progressed very fast and as a result they now harbour not only the rich vegetation of primary succession stages but also wild animals both vertebrates and invertebrates in good numbers- which was evident during the walks undertaken by consultant and scientists during sample collection and general survey.

3.5.2 Resettlement of Unauthorized Colonies

Out of the four unauthorized residential colonies (three in Bhatti area and one in Asola area with a population of over 16000), three colonies have been resettled after preparation of last management plan. The largest one namely Sanjay Colony deep inside Bhatti WLS continues there and has since grown in population. It remains to be one of the main source of anthropogenic pressure for both the sanctuaries. Because of their free ranging cattle in large numbers, cattle from other surrounding village also enter the sanctuary. Similarly the collection of fuel wood by head loads and even the collection of cow dung of stray cattle are rampant. The entry of people is unrestricted and they use the sanctuary for easing out and polluting it with garbage of all kind. At places even cutting of green trees was noticed. The position of reallocation of Sanjay colony is explained in detail in paragraph 3 of annexure II which will be suitably incorporated in the main management plan after updating at that point of time.

3.5.3 Release of Rhesus macaque inside WLS:

The release of over 18,507 monkeys from Delhi city inside the sanctuaries has put pressure beyond its carrying capacity. The few field staff that is looking after the WLS have to manage the feeding of such a large number of monkeys with the help of daily wage labours. Therefore other meaningful management activities are not being taken up.

3.5.4 Ecological Task Force in Restoration Work and raising compensatory plantation

1. As the area was extremely denuded and the afforestation task was difficult for the Sanctuary staff, the Govt of Delhi, approached the Territorial Army to raise one Eco Task Force for afforestation and protection of the notified Bhatti Wild Life Sanctuary.
2. 132 Infantry Battalion (Territorial Army) Ecological RAJPUT was raised on 09 Oct 2000. Hon'ble Chief Minister of Delhi, Mrs Shiela Dikshit and the Govt has the credit of raising the Eco Task Force which continues to be funded by the State. The Unit was affiliated to RAJPUT REGIMENT of Indian Army and comprises of the ex-servicemen from Delhi and adjoining areas. It was entrusted with carrying out afforestation, develop grass lands, develop water bodies, protect and conserve the Bhatti Wild Life Sanctuary.
3. 132 Eco Task Force first started its plantation in 2001 over an area of 300 acres. Deep Mining pits were covered by planting hardy species and direct seed sowing. Simultaneously, constant vigil and physical presence was maintained by establishing numerous out posts in the vast area to ward off cattle, encroachments and human interference from surrounding villages.
4. By end 2005, the area once again came under dense forest cover due to the sustained efforts of the Unit. The successes of the project prompted the Delhi Govt to extend the period of the project by another three years. In Feb 2006, the Unit's performance was recognized, when and additional Company was raised for a period of three years for the National Highway Authority of India (NHAI) for compensatory plantation in Ujjawa (Najafgarh). The Company was the first of its kind to be raised and funded by a public Sector Organisation. Compensatory plantation of 82000 saplings has been completed at the project site. Till now, 13.43 lacs of saplings have been planted by 132 Eco Task Force in very difficult and degraded areas encompassing approximately 3600 acres in Bhatti and Dera mandi.

3.5.5 Plantation done in past:- Forest Dept has laid down following annual targets for bringing the area under afforestation cover:-

Table 3.1: Plantation done in past

Year	Target		Target Achieved	
	Area In Acres	Plantation	Area In Acres	Plantation
2001-02	500	1,00,000	300	58,800
2002-03	400	1,00,000	600	92,400
2003-04	400	1,00,000	400	1,51,500
2004-05	400	1,00,000	400	1,26,000
2005-06	400	1,30,000	400	1,30,267
2006-07	400	1,40,000	400	1,40,000
2007-08	500	2,00,000	500	2,00,000
2008-09	600	2,00,000	501	1,67,000
2009-10	400	1,50,000	400	1,52,602
2010-11	400	1,50,000	348	1,30,000

3.5.6 **Types of Species Planted:-** Over the year, the unit has planted more than 46 species of different trees to increase the bio diversity in the area. The important ones are as below:

A. **Indigenous-** Desi Keeker, Sheesham, Apdi, Jangli Jalebi, Neem, Pipal, Dhak, Amaltas, Pilkhan, Bakain, Siras and Bamboo etc.

B. **Herbal/Medicinal-** Arjun, Belpattar, Bahera, Imli, Gwarpatha, Jangle Tulsi, Satawari and Katha etc.

C. **Fruit Plants-** Jamun, mango, Amrood, Sahtoot, Gular, Lasoora, Mahuwa, Amla, Falsa etc.

3.5.7 **Responsibilities of Eco Task Force**

a) Responsible to provide the manpower component for plantation work.

b) Provide manpower for transportation of seedlings/saplings and fencing material from local nurseries to the actual site of plantation.

c) Preparation of ground, digging of pits, plantation of seedling/saplings and grass slips, broad casting of grass seeds.

d) Watering of Plants.

e) Erection of fencing and watch and ward of the planted area.

f) Maintenance & Protection of project area.

The efforts of the unit have been recognized by conferring of two Chief of Army Staff Commendation Cards and four Army Commander's Commendation Cards.

Table 3.2: Details of year-wise plantation undertaken by ETF including their survival w.e.f. 2000-2010

Year	Target		Achievements		%age of Survival	Number of surviving saplings
	Area (in Acres	Plantation (in Nos)	Area (in Acres	Plantation (in Nos)		
2001-02	500	100000	300	58800	12.78	7515
2002-03	400	100000	600	92400	NA(8.6)	7946
2003-04	400	100000	400	151500	4.59	9240
2004-05	400	100000	400	126000	NA(4.06)	5115
2005-06	400	130000	400	130267	3.53	4598
2006-07	400	140000	400	140000	9	12600
2007-08	500	200000	427	200000	29	58000
2008-09	600	200000	429	141703	42	70140
2009-10	--	150000	--	150000	65	99191
Total	**3600**	**870000**	**3356**	**1190670**		**274345**

Table 3.3 Establishment Project Cost of Stores/Plantation

Period	Exp. On Project Stores	Exp. On Establishment Cost of ETF	Total Exp. Incurred/ likely to be incurred on the Project	%age of cost on project store w.r.t. total project cost	%age of establishment cost w.r.t. toal project cost
09.10.2000 to 31.03.2005	159.92	548.41	708.33	23	77
01.04.2005 to 08.10.2009	270.48	856.98	1127.46	24	76
09.10.2009 to 31.03.2010	55.13	63.91	119.04	46	54
Total	**485.53**	**1469.30**	**1954.83**	**24.84**	**75.16**
01.04.2010 to 31.03.2011 (Estimated)	197.37	724.28	921.65	21	79
01.04.2011 to 31.03.2012 (Estimated)	187.20	360.22	547.42	34	66

A. Total project cost incurred w.e.f. 09.10.2000 to 31.03.2010- Rs. 1954.83 lakh

B. Establishment cost of ETF paid to Min. of defence (PCDA)- Rs. 1469.30 lakh

3.6 Forest Protection

3.6.1 Legal status

The sanctuary is a legally notified Wildlife sanctuary as per Wildlife (Protection) Act'1972

3.6.2 Hunting and other illegal activities

3.6.2.1. Hunting

Hunting of wild animals, birds etc is not a serious problem in the wildlife sanctuary. Poaching of animals for commercial trade is not reported.

3.6.2.2 Illegal Collection of fire wood

Nearby villagers from Sanjay colony, Indira Colony & Balbir Colony do illegal collections of firewood by way of felling trees inside the sanctuary. There is a appreciable damage of the habitat.

3.6.2.2 Live Stock Grazing

Live stock grazing by cow, goats, buffalos, mules and even camels is very common. The owners intentionally damage the boundary wall and allow the animals to graze freely inside the sanctuary. The management has provided vegetative fencing in and around newly raised plantation areas. Trench cum mound at several locations have been constructed to stop grazing. In spite of all efforts its seems control of live stock grazing remains a challenge.

3.6.2.3 Thoroughfare

When mining was at its peak, hundreds of trucks loaded with badarpur and stones used to criss-cross through the WLS. The trucks would go to the excavation sites and transport material from the pits to the markets creating an haphazard road network. Now that the mining has been stopped the vehicular traffic has reduced. Still many a trucks/ tractors are found using the roads inside the WLS. Stoppage of unauthorized entries of all kinds will be possible only when sufficient staff is provided.

3.6.2.4 Habitation

Three villages namely Sanjay Colony, Indira Colony and Balbir Colony are situated within the sanctuary. These villages have existed for the last 40 years. Mainly the mine workers inhabit Balbir Nagar and Indira Nagar. Residents of Sanjay Colony are refugees from Pakistan. These communities have been using various natural resources of the area now a Sanctuary. Villagers settled around the sanctuary freely move inside for fuel wood and cattle grazing. Enclosing the Sanctuary a concrete wall of about 41 km in length has been created for protection. However, the wall has been broken at many places indicating that there is a continued trespass by the villagers. The people of Sanjay Colony are using a part of the Sanctuary as burial-ground. Playing of cricket and other games by groups of youth inside the PA is common. This leads to degradation of the habitat and persistent disturbance to animals.

3.6.2.5 Wild Fires

Wild fires occur in dry months. This results into damage to regeneration and the plantation activities.

3.6.2.6 Death of Wildlife due to road accidents

There are some contiguous patches of forest or park surrounding the WLS. Wild animals like nilgai, foxes, civets while crossing the roads may be getting killed but there is no record maintained.

3.7 Tourism and Interpretation

Another important positive development after last management plan is the creation of an interpretation cum extension centre by BNHS at the DCFs office inside the PA. They have been able to conduct some study excursions for students and bring out some brochures about the PA. They have also prepared checklist of birds and butterflies etc. A colourful brochure has been brought out by forest department of NCT of Delhi which needs updating and more publicity. The PA has good scope for large number of bird watchers in Delhi. With the help of BNHS some bird watching camp and training programmes can be started immediately. This will also give job opportunity to interested youth in the immediate neighbouring area.

3.8 Research Monitoring and Training:

3.8.1 Research works taken up in past

PA management has not carried out any research work in the Sanctuary. Some research works have been taken up by scientists of Zoological Survey of India (ZSI), on Faunal diversity of the Sanctuary. Vegetation survey by the scientist of FRI, Dehradun has also been taken up. The research work done in past is listed below:

1. Kumar & Khanna (1997) published a fauna profile of ABWLS based on the work of Kalpavriksh (1991), Sawarkar and Hussan (1991) and Zoological Survey of India (1997). The comprehensive and updated faunal profile provided incorporated inventory of 246 spp. of fauna including 35 spp. from invertebrates and 2 spp. of Amphibia, 3 spp. of Reptile, 196 spp. of Aves and 10 spp. of Mammalia from vertebrata.
2. The research team from ZSI headed by Dr. N.K. Sinha (1997), Dr. S.K. Gupta (1998), Dr. Vinod Khanna (1998) and Sh. J.P. sati (1999) came out with additional record of 64 more spp. which include 44 spp. from invertebrate and 3 spp. from pisces, 3 spp. of Amphibia, 4 spp. of Reptilia, 2 spp. of Aves and 8 spp. of Mammalia from vertibratia.
3. A check list of Mammals prepared by Alfred, J.R.B, Sinha N.K. and Chakrborty S. (2002) has been published by ZSI as accessional paper no. 199-1-289 (2002).
4. Research study under taken by Mahashman J.K. (1963) leading to the publication of the flora of Delhi (1-947) CSIR New Delhi.
5. A research note presented by Kalpvriskh (1-49) New Delhi (1991) titled 'The Delhi Ridge Founts Decline and Conservation'.
6. Research study undertaken by Sawarkar V.B. and Uniyal V.K. (1995) from Wildlife Institute of India, Dehradun for preparation of Management Planning of Asola-Bhatti WLS.

3.8.2 Monitoring

No Monitoring protocol could be developed for estimation of the population of the wildlife. Likewise no monitoring protocol is under practice for vegetation component. Management effectiveness evaluation of the Sanctuary was done by Mr. A.S. Negi retired Chief Wildlife Warden Uttarakhand in 2009.

3.8.3 Training

On the job training as well as formal training is totally lacking for the staff posted for the management of WLS. Training is one of the essential components of wildlife management.

3.9 Wildlife Conservation strategies and their evaluation

In fact no Management Plan exist for the P.A written as per the desired Management Plan manual. The Management Planning of the PA is a study report with 29 recommendations. As per the document five objectives were set aside out of which the first one was a long term objective and the rest four were attainable over a period of ten years, which was considered as establishment period. Restoration of degraded habitat have been achieved and is in progress. Meagre progress was achieved in monitoring the system response the objective two as measurable parameters were neither defined nor sufficient staff posting was done. The objective three regarding development of conservation education was a bit achieved with the development of a small interpretation centre at DCF office. Much of the prescriptions could not be taken up. Seeking co- operation of local people as per objective four remained a challenge for Park management. No positive development could be made in achieving the objective five regarding enhancing management capability. Till date beat demarcation do not exists. The earlier management planning recommendation did not prescribe the issue of management of large population of Rhesus monkeys which were introduced much later. This is at present a major management issue for both the staff and as well as the department.

3.10 Administrative set up

In the name of Frontline staff there is only one Dy. Forest Ranger In-charge of both the WLS and five Forest guards with 50-60 regular labourers. In the last management plan strengthening, reorganization and demarcation of existing ten beats was prescribed but that has not been possible due to lack of staff and over burdening the existing staff with monkey management. Bulk of staff is engaged in feeding & managing the rehabilitate monkeys. Management of two deer enclosures created as rescue centres for Chital and Black bucks after the past management plan also engages the already over-burdened staff. There is an immediate need to at least fill the vacant sanctioned posts and provide more labour to manage the already existing and additional duties that have been thrust upon the very few existing staff.

CHAPTER – 4

THE PROTECTED AREA AND THE INTERFACE LAND USE SITUATION.

4.1 The Existing Situation in the Zone of Influence

4.1.1 The location, extent, boundaries and natural attribute of the Z.I

The sanctuary having an area of 6873.28 acres is situated in the Southern Ridge of N.C.T. The sanctuary came into being vide Notification dated 09.10.1986 and 15.04.1991. The boundaries of the sanctuary are:-

North	-	Sangam Vihar, Durga Vihar colonies bordering Mehrauli - Badarpur Road.
South	-	Border with Haryana State.
East	-	Haryana interstate border & Road from Tughlakabad Fort to Suraj kund.
West	-	Asola, Fatehpur Beri & other villages of Delhi and Haryana state

4.1.2 Villages inside and outside the P.A, ethnic identities, traditions, customs etc.

Three villages namely Sanjay colony, Indira colony and Balbir colony are situated inside the sanctuary. The other adjoining villages around the sanctuary are Satbari, Sahurpur, Maidangari, Deoli, Anagpur and Surajkund. Many unauthorized residential colonies like Sangam Vihar have been settled in the fringe of the sanctuary. The resource dependence of these people is neither traditional nor of subsistence nature.

4.1.3 The state of people's economy, use of forest and non forest based natural resources by people

Out of the four unauthorized residential colonies (three in Bhatti area and one in Asola area with a population of over 16000), three colonies have been resettled after preparation of last management plan. The largest one namely Sanjay Colony deep inside Bhatti WLS continues there and has since grown in population. It remains to be one of the main sources of anthropogenic pressure for both the sanctuaries. Because of their free ranging cattle in large numbers, cattle from other surrounding village also enter the sanctuary. Similarly the collection of fuel wood by head loads and even the collection of cow dung of stray cattle are rampant. The entry of people is unrestricted and they use the sanctuary for easing out and polluting it with garbage of all kind. Migrant population even venture into cutting of green trees to meet up firewood requirement.

4.1.4 Implications of landuse and resource dependency for the conservation of P.A

The resource dependency which impact adversely the management of Asola-Bhatti wildlife sanctuary are:

- Settlement (legal and illegal)
- Livestock grazing and browsing
- Collection of fuel, fodder and non wood forest produce (NWFP)
- Commercial exploitation – mining
- Trespass & other disturbance by surrounding population.

Anthropogenic disturbances, such as grazing, and wood collection, may also significantly lower plant species richness in tropical dry forests (Budowski 1966; Sabogal 1992; Swaine et al. 1990; Jayasingam & Vivekanantharaja 1994; Maass 1995). Disturbances, especially by cattle, are infamous for compacting soil and destroying understory plant diversity (Veblen 1982; Janzen 1986; Gerhardt & Hytteborn 1992). Compaction by cattle reduces the volume and continuity of larger pores in the soil, thus diminishing the movement of water and air through the soil profile (Maass 1995). This process reduces the ability of certain seeds to germinate and damages trees and shrubs with shallow root systems. Intensive grazing by cattle can also result in an understory dominated by spiny or unpalatable shrubs. A number of studies found that wood collection lowers the species richness of fuel-wood and timber species, and favors stress tolerant plants and species that sprout after cutting (Sabogal 1992; Murphy & Lugo 1986; Ribichich & Protomastro 1998). In many areas where wood collection is intense, weedy lianas and vines tend to smother the tropical forest which further lowers species diversity (Savage 1992; Gentry 1995). The striking results of this study revealed that the Bhatti mines area, particularly, the mining pits of the sanctuary is the store house of plant diversity (in the case the Pit No 9 (Site 7) which holds 75 plant species that is remarkable to any dry topical forest), should be maintained so that it would set an example world-widely in respect of the management of dry tropical forest. This status of tropical dry forests have been reduced to less than 0.1% of their original expanse and the attention for the conservation of such forests is prerequisite (Janzen 1988). An example of the conservation value of the most endangered tropical dry forest ecosystem in the world is Central American tropical dry forest, which deserves a high priority for conservation (Janzen 1986, 1988). We believe that the tropical dry forest of Delhi Ridge needs high priority value for the conservation of valuable flora and fauna, which is also a natural asset for the abatement of Delhi's pollution. A detailed study of the composition of vegetation in the Asola-Bhatti

sanctuary of NCT of Delhi was done during 2001 to 2003 and 2010 to know the density and richness and regeneration of tree species along with the shrubs, herbs, climbers, grasses and sedges. The results are striking and reveal that the quarry pits of Bhatti mines holds the rich wealth of plants, as the area encompassing 23 tree species, 26 shrub species, 41 herb species, 9 climbers, 18 grass species, 3 sedge species and 1 bryophyte species after a fellow period of 17 years since 1991–1992 before that it was known for excessive mining for building making materials (badarpur). The quantification of vegetation revealed good density and frequency which is at par to the other similar forests over the globe. The area of the PAs being very small as compare to its concrete ladder counterpart arrangements given above may not hold good for its larger affects but if managed properly it can have tremendous weal benefits. This small area surrounded by vast urban population as also vulnerable to fast degradation and disappearance if not properly managed.

4.1.5 Forest/PA Management practices and their implications for people

Settlement in the enclave villages is new development and their subsistence is no way linked with the forest areas in a traditional way. Enforcement of WLP Act to achieve objectives of management of ABWLS will affect those who are dependent on resource utilization of the sanctuary.

4.2 The development programme and conservation issues

4.2.1 An evaluation of government and non-government agency programme for development, implications for P.A, people and Z.I

With a vision to afforestation of denuded areas of the sanctuary, the Govt. of NCT approachd to Territorial Army to raise one Eco-Task Force. The 132 Infantry Battalion(Territorial) Ecological Rajput was raised and got funding from the state. The task force started the plantation programme since 2001 with an annual target of 300 acres. The success of planting programme brought habitat improvement and greenery to the area. Simultaneously, constant vigil and physical presence by ETF Personnel was maintained by establishing numerous out posts in the vast area to ward off cattle, encroachments and human interference from surrounding villages. Another important positive development after last management plan is the creation of an interpretation cum extension centre by BNHS at the DCFs office inside the PA. They have been able to conduct some study excursions for students and bring out some brochures about the PA. They have also prepared checklist of

birds and butterflies etc. A colourful brochure has been brought out by forest department of NCT of Delhi which needs updating and more publicity.

4.2.2 A summary of problems faced by people that affect the management of the P.A. and Z.I

Asola Bhatti WLS after notification was fortified by rubble wall of 41 km around its boundaries. However the wall has been breached at many places. Similarly vehicular traffic has significantly reduced after ban of mining activities. In spite of ban house hold waste and garbage are dumped by inhabitants of the colonies inside the sanctuary. The unmanageable Rhesus macaque population in the capital region is captured and released in the WLS by various agencies like Forest Deptt., NMDC and MCD. There are some contiguous patches of forest or park surrounding the WLS. Wild animals like nilgai, foxes, civets while crossing the roads get killed.

PART---II

PROPOSED MANAGEMENT PLAN

PART – II

CHAPTER – 5

PLAN OBJECTIVES AND PROBLEMS

5.1 **Values of Asola-Bhatti WLS:** The sanctuary serves important functions at various landscape levels mentioned as under.

Global: Though AB-WLS is not large enough to contribute at global landscape level the typical diversity of flora and fauna of Aravalli hills, one of the oldest mountain ranges in the World, significantly makes its mark on bio-diversity conservation. Apart from this the deeply dug erstwhile mining pits now turned into perennial water bodies are definitely potential resting sites for winter migratory birds from North to South.

National: Asola-Bhatti WLS represents typical seat of transitions from semi-arid physiographic zone to Indo-Gangetic plains. Located on North-Western terminal of Aravalli hills Asola-Bhatti WLS attain its significance from its unique physiographic and bio-geographic location and rich history of ecological attributes.

It is the only Protected Area with over 2500 ha vegetated natural area sandwiched between Delhi & Gurgoan – Faridabad Urban conglomeration of over 15 M population. It falls in the semi arid bio geographic zone as per Rodgers & Panwars bio geographic classification.

Regional: The Southern Ridge of Delhi, where in, the Asola – Bhatti WLS is located, is reported to have supported a low density, dry deciduous scrub forest & savanna vegetation comprising typical flora & fauna of North Western Arawali.

Local: The strategic location of this natural area is definitely going to prove to be an effective high potential carbon sink apart from very good sink for other pollutants, thus literally symbolizing as green lungs for densely populated and highly congested Delhi and other adjoining areas of Haryana.

Being the seat of Transition Zone from Semi Arid to Gangetic Plains Bio-geographic zone, the entire Asola – Bhatti WLS could act as an effective barrier against the

advancing aridity from South West direction. It is conveniently accessed and ideally located to act as a centre for Biodiversity Conservation, Education & Nature Interpretation programme to spread the message of awareness about the nature & environment amongst nature lovers and school children.The deeply dug mining pits of the past, few of them are of gigantic dimensions act as stop over destinations for migratory birds. On attainment of fulfillment stage, the objectives can significantly contribute to cater the needs of aesthetic values and restore biological & ecological functions.

5.2 Objectives of Management

1. To restore and conserve the characteristic biological, abiotic and other categories of associated attributes represented in Aravali mountain range.
2. Rejuvenation and enrichment of Vegetation conforming to Aravali ranges in the highly impacted habitats to improve natural food base for fauna.
3. To establish a dynamic system of nature interpretation and conservation education in providing meaningful wilderness experience.
4. Enhancing the management capability.

5.3 Problems in achieving objectives

Each objective has to be examined in relation to the existing or potential problem capable of thwarting the realization of that objective.

5.3.1. Problem in achieving objectives No. 1 – Restoration of Aravali Bio-diversity

5.3.1.1. Due to heavy mining done in past large quantity of top soil either got excavated or eroded. Passing of vehicles in the sanctuary also did compaction of soil unfit for regeneration of forests. Though the mining has now been stopped but the trespass by all vehicles and peoples still continues detrimental to flora and fauna.

5.3.1.2. Use of biomass in the form of fuel wood, fodder by nearby villagers adversely affects the recovery of vegetation.

5.3.1.3. Stray animals and grazing by nearby cattle owners poses threat in regeneration of vegetation.

5.3.1.4. Encroachment by unauthorized colony poses threat to biological restoration.

5.3.1.5. Lack of awareness and people co-operation.

5.3.1.6. Badarpur mining in surrounding area of WLS.

5.3.2. Problem in achieving objective No. 2 – Rejuvenation and improvement of food base for fauna.

1. *Prosopis juliflora* introduced in past have significantly brought greenery in the WLS area. However it causes reduction in ground cover and grass biomass and does not allows other species to establish.
2. The area is over grazed by livestock.
3. Shallow soil depth, compact of impoverished soils affects vegetation association.
4. Over exploitation of species like *Butea monosperma, Anogeissus pendula* for fodder and fuel.
5. Water conservation attempts not taken in past.
6. Stray animals and grazing by livestock.
7. Lesser protection infrastructure.

5.3.3. Problem in achieving objective No. 3 – Nature interpretation and conservation education.

1. Unhygienic use of the area by nearby settlers.
2. Dumping of garbage and rubbish around WLS boundary areas.
3. Unrestricted movement of people, vehicle in WLS.
4. Lack of publicity material, guides, training and interpretation facilities.

5.3.4. Problem in achieving object No. 4 – Enhancing management capability.

- Shortage of field staff
- Training to field staff lacking
- Over aged staff
- Lacking of empowerment under relevant laws
- Existing staff unable to concentrate on management issue due to extra burden of feeding and maintaining large population of rehabilitated monkeys.

CHAPTER – 6

THE STRATEGIES

6.1 General

The sanctuary is located in the south eastern part of southern Ridge, Asola Wildlife Sanctuary (4707 acres) was carved out from community land in 1986. Subsequently in 1991 another notification was issued to declare Bhatti (2107 acres) as Wildlife Sanctuary. The total area as per notification for Asola-Bhatti WLS is 26.82 sq km (6814.00 acres or 2682.67 Ha). Biogeographically Asola Bhatti WLS represents a landform not earlier represented in national P.A. network – the Aravalis. This Sanctuary is very different from popular perception of a sanctuary. Decades of abuse of the area has resulted in serious biological degradation and in the foreseeable future it is most likely to attain the status of show place for wildlife. The heavily mined area is now full of greencry by natural succession assisted by human intervention. However still its degradation continues due to high cattle grazing, removal of biomass, unhygienic use, rubbish dump, travel shortcuts between settlements etc. To overcome the problems suitable strategies needs to be developed. Strategies are practical means of achieving objectives.

6.2. Boundaries

The P.A. is small and represents a portion of highly fragmented landscape. Even at its best, it is going to be a habitat island with low diversity of plants and animal species and relatively low wildlife populations (MacArtlur and Wilson 1967, Harris 1984, Soule 1986, Hunter 1990). The most abundant group will be constituted by birds followed by reptiles, mammals, fishes and amphibians in that order. Larger vertebrates are going to be very few and will be represented by small populations. Black buck has been introduced in the area with enclosures. Their health and population needs to be monitored. Nilgai have adapted to the area. The immigration possibilities of other dry habitat species are remote since there are no corridors left that might connect the PA to large patches of forest. It is likely to be a completely isolated habitat island. However, monkeys captured in large numbers from human habitats in Delhi, are being trans-located into the PA. Keeping large population of trans-located monkeys is a real challenge to park management.

6.3. Zonation and Zone Plans

A Zone is an area of specific management category distinguishable on account of its objectives. The number and kind of Zones that are required depend on the objectives and how different they are with respect to each other so as to necessitate the separation of strategies by area. Thus spatial separation process is usually referred as Zonation. Presently there is no separate demarcation of core and buffer zones is ABWLS. With the ban on removal of biomass from WLS area as per Hon'ble Supreme Court of India, now there is hardly much difference in core and buffer zone. Asola Bhatti WLS put together have an area of 6873.28 acres. The PA is very important and vital owing to its location amidst in large metropolis which also happens to be the capital city of the country. Apart from their bio-geographical and physiographic location they serve as important carbon sink and green lungs for the thickly populated city. The PA is therefore very important to be conserved as green cover with maximum possible biodiversity of flora and fauna. Protection of the entire area as a unit is therefore of vital importance. This being in a capital city can also become popular destinations for students, researchers & conservationists and will need to be managed with that angle as well. Considering the above facts the zonation of this small PA has not to be conventional but strategic in nature. The entire area needs to be disturbance- free in the strict sense.

As per the management needs and objectives of management following zones are prescribed –

1. Core zone
2. Eco-tourism zone
3. Habitat Restoration zone
4. Monkey Rehabilitation Zone (overlapping)

6.3.1 Core zone

Under this zone areas having moderate to high dense forest areas have been taken up. The core zone is proposed to be managed as free of all biotic interferences including prohibition of entry of unauthorized person. It will allow ecological process to continue. These are the areas mostly abandoned pits which have struck water. The aim is to let aquifers keep charging the pits are now an inherited attribute and should not be any attempt to modify the slopes or filling pits. New habitats are developing and the process needs to be supported by complete protection of pits. *Acacia* –

Anogeissus – Maytenus vegetation type is significant as wildlife habitat and needs full protection. Other areas bearing *Carissa carandas, Zizyphus mmuleria, Butea monosporma* have been put under this zone.

The proposed activities are as follow –

i. The area has to be kept free from biotic interference like grazing, removal of fuel-wood and encroachment etc.
ii. No rights and concession from this area be allowed.
iii. Strict vigilance to prohibit unauthorized public entry.
iv. Protection from fire by way of laying fire lines and its maintenance.
v. Construction and maintenance of waterholes can be taken up.
vi. Maintenance of infrastructural assets inside the zone like protection camp, watch tower, water bore well, road etc. can be taken up.
vii. Scientific study can be taken up.
viii. Soil and water conservation measures can be taken up as and where necessary.
ix. Removal of weeds and lantana can be taken up in the area to allow regeneration.
x. Planting of fruit bearing trees as monkey rehabilitation (overlapping activity) in open areas.
xi. Monitoring through periodic bi annual animal census.
xii. Plantation activities including replacement by indigenous species can be taken up in open areas.

6.3.2. Eco-tourism zone

This will consist of interpretation centre, black buck and cheetal enclosure, nursery, old grove, large lake with migratory birds and network of nature trails, birds trail and other proposed activities. To foster public understanding and appreciation of the sanctuary and its biological, geological, historical significance this zone is proposed at following two locations –

i. Eco-tourism zone – Tughlakabad (Asola) – zone I
ii. Eco-tourism zone – Bhatti – zone II

The detailed prescription of the activities to be taken up has been highlighted in chapter 7.

6.3.3. Habitat Restoration zone

In a haste to develop green cover over the entire area, the administration undertook extensive seeding and planting with several tree species of which *Prosopis juliflora* and Acacia sp. have been successful. *Prosopis* has already formed dense thickets with closed canopy in some areas. It is likely that other areas may be covered by *Prosopis* if management intervention is not done. It has been found that plots under *Prosopis* showed a significantly lower ground cover than other plots. With an aim to increase food base to herbivores and large population of primates it is felt necessary to enrich the vegetation conforming to Arawali Ranges. Open degraded areas under high biotic pressure, area heavily infested with lantana and erosion prone area have been taken up under this zone.

1. The proposed activities are as follow –
2. Eradication of *Prosopis juliflora* and replacement with indigenous vegetation Aravalli vegetation. Plantation activities by indigenous species can be taken up in open areas as is being taken up by Eco-Task Force.
3. Eradication of Lantana by uprooting and cutting followed by repeated cutting .
4. Maintain silvi- grassland up-to an area of one acre for wild herbivores.
5. Various soil conservation measures like gulley plug, contour trench, farm bunds, vegetative check-dam etc. can be taken up in this zone. Even grass seeds of stylo, hamata spp., napier grass and signal grass can be sown on the bunds which will stabilize the bunds and also provide fodder to herbivores.
6. Protection from fire by way of laying fire lines and its maintenance
7. Construction and maintenance of waterholes can be taken up.

6.3.3.1. Choice of Species

While choosing the species of plants for planting activity only the native species must be chosen. It may sound strange, especially since the PA is already dominated by exotic species. However, a mistake already made need not receive continued support. Cutting or uprooting *Prosopis* over patches of different size or pruning need to be done. Continuous removal of *Prosopis* should not be attempted. The objective is to create better regeneration and growth opportunities for native species of grass, herbs, shrubs and trees. The tree species proposed for planting in enrichment zone are – *Zizyphus nummularia, Capparis sepiaria, Anogeissus pendula, Carrisa carandas,*

Acacia leucophoea, Acacia nilotica, Boswellia serrata, Cassia fistula, Guava, Gular, Lasoora, Mahua, Falsa Ficus spp.

6.3.3.2. Planting technique

The area to be taken up under enrichment planting be demarcated one year in advance. Pits of size 90 cm X 90 cm, including contour trenching should be prepared. Since the soil is not fertile provision for use of manure and fertilizer@ 1 kg vermin-compost, 1 kg neem cake and 50 gm NPK per sapling needs to be provided. Insecticide @ 20 gm phorate per plant also need to be applied. Provision for irrigation @ 8 irrigation per month in 1st three years, thereafter 4 irrigation per month in 4th & 5th year be kept during dry months based on actual requirement. The plantation raised should be maintained upto 5 years.

6.3.3.3. Planting by Eco- task Force

Eco-Task force work in greening Asola-Bhatti is well recognized. Till 2011-12 it has taken up planting in 4249 acres (1673.00 Ha). It needs to be continued during the Management Plan period. The constant vigil and physical presence by Eco-Task Force ward off cattle and human interference from surrounding villages.

6.3.4. Special Habitat Restoration for Primates

Monkeys mainly Rhesus macaque captured from human habitations in Delhi are being trans-located to the sanctuary. In absence of natural predator their population has increased many fold. 18,507 numbers of Rhesus macaque have been trans-located in the sanctuary till January 2015. Asola-Bhatti mainly tropical thorn forest is unable to meeting up the natural food to these primates. This situation has compelled the authorities to feed vegetable and fruits artificially. There are 18 platforms for feeding the macaques. Approximately Rupees one crore annual expenditure is incurred for this purpose. This cannot be sustainable. In view of this it is proposed to do planting of fruit trees species like *Ficus religiosa*(pipal), *Ficus bengalensis*(Bargad), *Morus indica*(toot), *Zizyphus mauritiana* (Ber), *Zizyphus nummularia* (Jharber), *Zizyphus zizyphus* (Chinese jujube), *Aegle marmedos* (Bael), *Prosopis sinnereria* (Shami), *Mangifera indica* (Am), *Psidium guajava* (Guava), *Cordia dichotoma* (lasoda), *Grewia asiatica* (Falsa), *Madhuca longifolia* (Mahua) etc in the areas wherever found

suitable. This is a overlapping management activity over all the three zones mentioned above.

6.4. Theme Plan

Not all management strategies are restricted to zones or zone plans. Several strategies to achieve the objectives fall in a zonal category or strategies which are common to two or more zones like fire protection, protection from illegal fuel wood collection, water supply and soil and moisture conservation, weed eradication.

6.4.1 Management of Mined Areas

Major mining activities were concentrated in Bhatti area, and it was being carried out by open cast mining methods, which resulted in creation of mined pits. There were about 200 mined pits of various sizes ranging from about 20-30 m deep, smallest to larger dimension pits. The mining resulted into three distinct physiographic conditions:

1. Mined out pits having two distinctive compartments i.e. Bottom or base of pit and vertical side.
2. Mounds of overburden near major pits.
3. Undulating surface area untouched by mining.

The soil is shallow dry and sandy with high porosity and low humus content. The area supports xerophytic open canopy scrub forest in rocky dry places and mesophytic plants in moist sites. The native tree vegetation of the area includes: *Accacia nilotica, A. leucophloea, A. modesta, A. catechu, Anogeissus pendula, Azadirachta indica, Butea monosperma, Cassia fistula, Dalbergia sissoo, Diopyros cordifolia, Ficus religiosa Flacourtia indica, Holoptelea integrifolia, Wrightia arborea*

Native shrubs include: *Balanites aegyptica, Capparis sepiaria, C. dicidua, Carissa opeca,* Grewia *tenax, Fluggea virosa, Meytenus senegalensis, Tephrosia purpurea, Ziziphus numularia, Z. oenoplia.*

Grasses consisted mainly: *Dactyloctenium aegyptium, Brachiaria ramose, Chloris dolichostachya,* Saccharum *spontaneum, S. bengalensis, Phragmites karka, Heteropogon contortus, Cynodon dactylon,etc.*

Objectives of Restoration of Mined Area

The aim of restoration of mined lands should be to bring mined degraded lands into its previous condition. It should have following objectives.

1. To protect the area from degradation and soil erosion.
2. To conserve and enhance native species diversity.
3. To ameliorate and enrich soil condition
4. To convert degraded ecosystem into productive one, so that it could fulfil its ecological and environmental functions.
5. To make habitat suitable for wildlife.

These objectives could be achieved through applying ecological principles in the process of restoration. How the natural process of succession is progressed in the respective area is key factor in determination of approach for the success of restoration.

Strategies for Restoration of Mined Areas

After notification of WLS and closing of mining activities, some measures have been taken to re-vegetate mined out areas in which planting as well as seed broad casting of Prosopis juliflora a species native to Mexico was done. *Prosopis juliflora* being exotic and invasive species has overtaken the entire area. No doubt this species has converted a degraded land into thick forest of *Prosopis juliflora,* but it has checked natural process of succession in this area. If restoration measures considering the ecological principle were taken at the beginning, the condition of WLS could have been different than the existing one. There would have been a good combination of native species. Due to shading effect, allelopathic property and competitive interaction, *Prosopis juliflora* checked regeneration of native species. Besides it causes a significant reduction in ground cover and grass biomass. Though the Bhatti WLS is fully occupied by *Prosopis juliflora*, yet there are some places where certain native tree species could be seen. This indicates that there is still scope for introduction of native species. Interestingly species like *Ficus religiosa, Azadirachta indica* are found to be growing in crevices of rocks.

Following management practices to control soil erosion, conserving native vegetation and enriching biodiversity can be adopted:

1. Planting of native tree species particularly *Dalbergia sissoo, Azadirachta indica, Acacia catechu, A. nilotica, Cassia fistula, Ficus religiosa, Holoptelea integrifolia*, after thinning out of close canopy of *P. juliflora* to create space for these species.
2. In vertical slopes, where certain areas are exposed, planting of grasses such as *Saccharum spontaneum, S. begalensis, Dactyloctenium aegypticum, Cenchrus ciliaris* and *Cynodon dactylon* can be done.
3. In the crevices of rocks, seeds of *Azadirachta indica* and *Ficus religiosa* can be sown. This can be done either using hydro seeding or ball plantation.
4. There are certain areas where gully formation is taking place. The advancement of these gullies could be checked by applying appropriate mechanical measures and subsequent planting of grasses and shrubs.
5. For biodiversity conservation the area should be protected from biotic interferences. This can be done by enforcing the legal provisions of Wildlife Protection Act 1972.

6.4.2. Wetland and Water Management

Due to predominantly sandy nature of soil, the surface run off is low and rain water seeps down in the underlying rocks. There are some perennial water sources like Paniwala Khan near Haryana border and Jatonwalla Johar in south west part of sanctuary. As many as 31 water sources including tube wells are reported.

Bhatti portion of sanctuary has several large pits. They have struck water. A typical wetland vegetation community has now developed. Water fowl, mainly ducks and teels can be seen. The sloping sides of pits like, natural hedges are being used as nesting sites-by birds. Certain amount of erosion might be seen during rainy seasons, however any attempt to modify slopes or filling pits is not recommended. These are not dangerous to native animals. At best, a railing could be established placed at sufficient distance from rim of the pit for safety of the visitors at locations where planned Eco-tourism programmes are expected to be introduce any fish species in the wetlands at the bottom of pits. All forms of fishing activities are banned under Wildlife Protection Act 1972.

Water availability is a problem both for wildlife and human during pinch period. Asola-Bhatti represents a dry ecosystem with natural 'scarcity of water', therefore creating too many water holes will not necessarily be of any advantage. Bore wells seems to be best option, since bunds are not likely to hold water through the critical part of summer. Maintenance of existing water holes needs to be taken as per routine work. The existing system of supply of water to some points by way of water tanker is recommended. Existing water tankers are not sufficient therefore procurement of new water tanker is required.

6.4.3 Soil and Water Conservation

The thin soil layer needs to be protected from further erosion by way of various methods adopted in field. The basic principle of soil conservation is that velocity of water flowing during the surface runoff is reduced. Various soil conservation measures like gulley plug, contour trench, farm bunds, vegetative check-dam etc. are constructed to reduce water velocity and reduce soil erosion. Soil moisture conservation work is generally taken up on "Ridge to Valley" approach starting from top and coming downwards. Gulley plug by using locally available boulders constructed across steep and mild slopes is effective. The dry stone masonary wall allows water to flow but allows the soil to deposit through it. Once degradation is stopped biomass is generated and regeneration comes up. Even grass seeds of stylo, hamata spp., napier grass and signal grass can be sown on the bunds which will stabilize the bunds and also provide fodder to herbivores.

6.4.4 Rain Water Run-off Harvesting

Rain water runoff harvesting has been adopted in many areas of world considering its importance in areas here conventional water supply systems are not available or have failed to meet the needs and expectation of the people. Traditional system of ground water recharge in arid and semi arid regions have been Khadins, ponds, anicuts, recharge pits and trenches. The various mined pits inside the sanctuary are also helping in ground water recharge.

6.4.5. Fire Protection

Fire incidents due to human disturbance is damaging to plants as well as wildlife. Following activities are prescribed:

1. The boundary wall around major portion of Sanctuary acts as a fire barrier and keeping a line clear of vegetation inside the wall will prevent spread of force to the PA. All roads inside the sanctuary also needs to be used as as fire lines by keeping width on either side of the roads and paths of vegetation. This also marks a newline for watching birds & animals

The fire will become minimal once trespass and encroachment are removed. No separate fire lines will be necessary for this small PA. Special visits will be required in areas close to habitations during fire season. Existing watch towers can be used as fire watch towers as well. Appropriate signages could also be displayed at strategic place.

2. Roads also act as natural fire lines. Therefore cutting of undergrowth and removal of debris along road should be done before fire season.
3. Compartment boundary demarcation by clearing undergrowth for a width of 3m will act as fire lines.
4. Appropriate signage about evils of fire be placed nearby Eco-tourism zone.
5. Existing watch towers can be utilized by fire watchers during fire prone season.

6.4.6 Weed Eradication

Weed infestation in the sanctuary is a menance which reduces grazing potential for wild herbivores, hinders regeneration and is fire hazard as well. Lantana and congress grass (*Parthenium hysterophorus*) are the problematic weeds in the sanctuary. Weed eradication for the first five year is proposed. Manual up-rooting of it till 3 years to ensure that it does not reappear is prescribed. It is to be followed by enrichment planting with indigenous fruit and fodder species like *Ficus religeosa, Zizyphus nummularia, Pisidum guajava, Ficus bengalensis, Butea monasperma etc.*

Following strategy is prescribed for eradication of weed.

I. Identify areas of weed and eradication by uprooting manually during rainy season before maturing of seeds to avoid seed dispersal.
II. Uprooting to be done in 2nd and 3rd years in the same area to check recurring weeds through root suckers and dormant seeds.
III. Uprooting should not be done on slopes having more than 30 degree elevation initially where cutting from the middle stem should be done. When soil binding species are established the root suckers etc should be uprooted.
IV. *Partheniumm* should be eradicated by manual cutting 2-3 times in a year.
V. To supplement natural regeneration of indigenous species, planting of *Ficus religeosa, Zizyphus nummularia, Pisidum guajava, Ficus bengalensis, Butea monasperma* etc be done.
VI. In isolated patches of forests infested with Lantana, physical removal be taken up from the edges and move inwards to prevent reseeding of patch cleared by weeds.
VII. Standing trees and snags may be retained for nesting of birds.
VIII. Care should be taken for retaining natural herbs and indigenous shrubs while uprooting.

6.5. Protection

6.5.1. General

Protection of habitat, land and its resources remains one of the main challenges. The main constraints in protection are:

a) Shortage of field staff and acute shortage of wild life trained staff.
b) Available man power not adequately trained
c) Field staff not aware of their legal powers nor there dreams to be any will to implement it.
d) Lack of mobility and other equipment.
e) No beat protection system being followed
f) Lack of motivation to field staff
g) Most staff including in-charge of PA totally busy with Monkey feeding.
h) Presence of colonies inside PA

6.5.2. Boundaries

While sanctuary boundaries are mostly well defined by a wall, the demarcation over a section along southern portion is not clear, presumably this is because of dispute. However some directional markers as per claim of sanctuary management need to be established for knowledge of local and eco-task force. The breaching of wall intentionally by some vested people to allow their cattle for grazing must be dealt strongly and the damaged portions of the wall must be repaired.

6.5.3. Protection by Eco-task force

Taking into consideration the acute shortage of field staff engaging Eco-task force in protection works may be considered. It has been found that Eco-task force personnel camp inside the WLS area for carrying out plantation and their maintenance. Their physical presence in PA will control many illegalities.

6.5.4. Protection Camp

At present most of the field staff live outside the PA and all the daily wage staff engaged for various activities also comes from far off places. There is enough space near the DFO's office where there is a nursery and the BNHS centre for providing accommodation. It will be desirable to construct some accommodation for field staff here and as well as near Sanjay Nagar colony where there is Range office. Some

accommodation for daily wages staff will also be necessary as they can be easily mobilized at odd hours for protection duty.

6.5.5 Encroachment

Unauthorised encroachment in any part of the sanctuary needs to be dealt immediately. Many a times new constructions are being taken up in pretend of repair of exiting one.

6.5.6. Re-organization of Beat

Currently the sanctuary has no beat system. This should be formalised with demarcation on the ground and on maps. Currently, the sanctuary does have a loose system of beats. This should be formalised with demarcation on the ground and on maps. The protection of each beat must be the responsibility of specifically assigned Guards whose work should be supervised by beat officers and then by the Range officer in an ascending order of hierarchy as already established within the forest departments. Each member of the field staff should have a cut and paste type topographic map, especially of his own jurisdiction. Thus Guards must carry their respective beat maps, enlarged to the scale (1:8000). Each map should have super scribed feature, such as roads, location of pits, area in which grazing is permitted, areas of plantation activity, sources of water, sections of the protective wall, and administrative or management units such as eco-education areas, conservation zone, eco-task force location etc. It should not be difficult to develop a framework of compartments by using topographic features and assigning each unit a serial number. This framework should first be developed on a topographic map and then demarcation features be established in the field, which mostly will be natural and where necessary, dry rubble cairns be established with serial nos. Thus any event or activity can be tied down to locations on the ground. Such a framework needs no justification, neither any elaboration as regards its utility. This is a standard approach followed by the state forest departments. A compartment constitutes the smallest unit of management on spatial scales.

6.5.7. Patrolling Schedule

The protection and management responsibility of each beat, if necessary can be shared jointly by two or more guards assisted by daily wage staff which is already

employed. Patrolling schedules must be developed. Thus, as a system, across the sanctuary an efficient mechanism of protection is required to be established. At strategic locations one or two patrolling sheds of economic construction and design which merge into the landscape should be established. The purpose is for theses is to serve as shelter during the day in rains and hot summers and as an overnight camping place for the patrolling staff. This will also encourage the field staff to remain in the field and will enable establishment of a tradition. Each beat Guard must maintain a daily diary of his activities on duty, the area patrolled, management activities implanted, events of management significance detected and action taken. Supervising staff should scrutinize these, at least once a week. All field staff, irrespective of rank must maintain such documents, which will be a permanent record and should be available for scrutiny any time by authorised officials.

6.5.8. Orientation of Field staff

The field staff will need to be oriented to this system, especially in the matter of what is expected of each level of responsibility and how to record and what to record. This is best developed in the field as an 'on the job' orientation. All protection related events must find a place on record eg. detection of a breach in wall; illegal cattle grazing; illegal collection of fuelwood, fodder, cutting of trees; fire incidents, location and control measures; trespass; poaching etc. The record should also reveal the progress of implementation of management activity assigned. Supervising officials must record their findings on such diaries and pursue management action as necessary. It need not be mentioned that map reading capability is a must at all levels.

6.5.9. Vehicle

An important aspect of protection is the capability of being able to reach the spot in the field with minimum loss of time. Such mobility alone can act as an effective deterrent. Range officer should be provided with a Gypsy. Each beat Guard should be provided with a motorcycle.

6.5.10. Check gate

Some check gates constructed in past need maintenance. The roads closed at check gates be chain locked. If the sides allow a vehicle an opportunity to skirt the barrier,

then trenches be dug on either side where they meet a boundary area or such topographical difficulties.

6.5.11. Training

Currently, the field staffs are not trained and hence the existing force is week in meeting the challenges. Staff at the level of forest guard, forester and Range officer must be fully trained in their field tasks. Such training can be had from various training institutions established by Forest departments. There is a Forest Guard training school at Pinjore, Haryana where Guards could be trained. 3 months certificate course in Wildlife management at WII, Dehradun should be compulsory for Range officer posted under Asola-Bhatti WLS. Along with formal training 'on job training' on the following subjects should also be done by Park management-

a) Legal issue involved in Wildlife offence and enforcement.
b) Training in intelligence gathering and processing.
c) Training to staff in Wildlife crime detection, inquiry and production of offenders in court of law
d) Refreshers course at different level

6.5.12. Roads

The sanctuary has substantial jeep able track length. The existing tracks need to be cleared of vegetation especially *Prosopis*. Roads developed in Eco-tourism zone can be used by visitors. Other roads inside PA should remain closed for visitors.

6.5.13. Communication

The field staff should be provided with mobile phones. A glimpse of certain action needing immediate attention of the managers has been outlined in above points. These along with the other detailed prescriptions necessary for this small WLS with its unique character will form chapter 6 to 12 of the main Management Plan along with necessary Annexures. Maps of the PA are enclosed as Annexure. Strategies are practical means of reaching objectives. It is seen that most of the strategies adopted by the park management presently are in line with the objectives of the management plan and so have been retained with minor modifications. The strategies are being discussed and evolved by the wildlife consultant in detail.

CHAPTER – 7

TOURISM, INTERPRETATION AND CONSERVATION EDUCATION

7.1 General

Wilderness recreation is an important value and has an important role in support of management. It can directly benefit the cause of conservation as tourism can expose diverse categories of tourists to the process of conservation education which is best achieved in the field. Conservation education and nature interpretation are therefore integral to wildlife tourism. However, tourism can also generate pressures that can adversely affect the PA and create administrative problems.

Tourism, therefore, can be allowed inside the sanctuary on a limited and regulated basis provided it does not cause disturbance to the environment, wildlife and its habitat. It is emphasized that although conservation and protection of natural resources and wildlife should be the main aim but environmentally responsible travel and regulated visitation should also be allowed. It is important to educate people about the biodiversity and conservation while also building mass support through them by enhancing visitor's experience.

Thus wildlife tourism is a growing concern which has already established its usefulness in the overall objective of conservation.

7.2 Objective

i. Educate people about the biodiversity/ wildlife and need for their conservation.

ii. Create awareness amongst a larger section of the society and gather public support.

iii. Improve quality of educational recreation and wilderness experience.

iii. Promote species conservation

7.3 Strategies

Asola Bhatti WLS is small in extent with little experience of wildlife sighting and outdoor thrills. The proximity of the PA to the National Capital, presence of nature conservation organizations and educational institutes make the sanctuary very important. The advantage of BNHS which has a centre in the PA and eco-task force which has an eco-park in the Bhatti WLS can be expanded further. To foster public understanding and appreciation of the sanctuary and its biological, geological, historical significance this zone is proposed at following two locations –

i. Eco-tourism zone – Tughlakabad (Asola) – zone I
ii. Eco-tourism zone – Bhatti – zone II

It is possible to connect some of the existing features of education value and makes some trails connecting the following.

1. BNHS centre
2. Nursery
3. Water body
4. Deer enclosures
5. Old forest grove
6. One or two old mining pits
7. Eco-park of ETF
8. One or two very successful plantation sites of ETF

These features can be divided into 4 to 5 trails of 3 to 5 km length and each one can be suitably developed into an educational feature by labeling trees and other features. The nature trail should be free of garbage, trespass, stray animals etc. and at a time only one trail can be permitted for which a roaster can be made for 6 days of the week with a break of one day. Bird watching groups or individuals can also be allowed on the same trails. A system of nature guide can also be introduced by training few local youth and registering them either with BNHS or the PA management.While the major responsibility of establishing and maintaining these infrastructure and programme will be of the Forest Department, it is strongly recommended that interested NGO and Nature Clubs be involved in the Interpretation and Conservation Education Programme of the sanctuary. Interested schools and universities also need to be involved in these programmes. To achieve this formal arrangement at the highest level of administration needs to take initiative. A "Save-the–Lungs of Delhi

"Committee comprising of Development Commissioner (as Chairperson),NGOs, Nature Clubs and representative from Schools and Universities and the DCF (Wildlife) needs to be created which would supervise the Conservation Education and Interpretation Programmes and protection of the sanctuary. Signages about the wildlife and birds may be displayed at appropriate locations for awareness of visitors.

7.4 Visitor statistics

At present the level of visitation for ecotourism or education purposes is almost nil. Therefore, no visitor statistics were available. Considering the fact that Asola -Bhatti Sanctuary is quite close to the National Capital of Delhi the target groups identified are:

I. General public including those in the neighbouring localities.
II. School and University students.
III. Researchers, NGOs and similar other interest groups.
IV. Bird watchers, nature lovers and those interested in nature interpretation and education activities.
V. Wildlife enthusiasts.

7.5 Interpretation and Conservation Education

Interpretation means a process of developing visitor interest in an area so as to enable him to appreciate the intricacies and have a better perception and understanding its beauty and complexity. It should clear the doubts and provide information of the area and its importance without asking. The interpretation center is to be designed so that maximum information is displayed through writ ups, photographs, file pictures, specimens etc. along with the history of the area.The important feature of animals/birds/reptile and their interdependence should be displayed through innovative photographs. The language should be catchy which should stick to the mind of the reader for long. The interpretation centre should have the following facilities:

i. Reception cum information desk
ii. Three dimensional replica of the area
iii. Souvenir shop
iv. Diorama display of park
v. Photomurals, laminated informative maps
vi. Digitized call of animals and birds

vii. Interpretive signs-It should be weather and vandal proof, blending with background and bilingual at a convenient height.

7.6 Regulation, Monitoring and Evaluation

7.6.1 Regulations

i The eco tourism zone of sanctuary should remain opened to visitors through- out the year except Gazetted Holidays. Additional restriction can be imposed by the management taking in view of breeding season of wildlife and road condition.

ii. Entry to WLS should be allowed only to the permit holders issued by CWLW.

iii. The speed of vehicles inside the WLS will no exceed 10 KM per hour. Te sanctuary can be visited between sun rise to sunset and no night stay inside will be allowed.

iv. Trekking on foot will be allowed only on the identified trails.

v. Shouting, blowing of horn or making of other kind of noise is prohibited.

vi. Carrying of arm/weapons inside theWLS is punishable offence.

vii. Dogs/pets are not allowed inside the WLS.

viii. Use of spot light/ search light and flash on camera is restricted.

viii. Carrying of liquor, cigarettes and lighters are not allowed.

ix. No littering by way of plastic bags, mineral water bottles, wrappers, plastic glasses, cold drink bottles etc shall be done inside WLS. However dust bins blending with nature may be provided at appropriate locations.

x. Tourists are advised not to carry radios, tape recorders, transistors, inside the sanctuary.

xi. The provisions of Wild life (Protection) Act 1972 shall be strictly enforced.

xii. The management will display DO's and DON'T to visitors at prominent locations.

xiii. Fines will be imposed by the management on contraventions of the rules.

xiv. Wilderness zones should not be opened for tourists.

7.6.2 Monitoring and Evaluation

To monitor the various impacts on habitat and fauna, an analysis of tourist information on the lines of purpose of visit, type of visitors, level of soil compaction due to such visit, waste generation and change in animal behaviour needs to be done to review the prescriptions of the Management Plan.

CHAPTER 8

ECO-DEVELOPMENT

People's participation is an essential ingredient of any programme addressing public related issues. The implementing agencies may be repositories of knowledge, experience and technology but understanding of people's wants is critical for success. Therefore, people's aspirations have to be considered honestly after discussion with them. Hence eco-development is a site specific conservation friendly package of measures for environmentally compatible development and biomass use to complement management of P.As with the objective of reducing the local communities on forest based natural resource management.

Three villages namely Sanjay colony, Indira colony and Balbir colony are situated inside the sanctuary. The other adjoining villages around the sanctuary are Satbari, Sahurpur, Maidangari, Deoli, Anagpur and Surajkund. Many unauthorized residential colonies like Sangam Vihar have been settled in the fringe of the sanctuary. It remains to be one of the main sources of anthropogenic pressure for both the sanctuaries. Because of their free ranging cattle in large numbers, cattle from other surrounding village also enter the sanctuary. Similarly the collection of fuel wood by head loads and even the collection of cow dung of stray cattle are rampant. The entry of people is unrestricted and they use the sanctuary for easing out and polluting it with garbage of all kind. Migrant population even venture into cutting of green trees to meet up firewood requirement. The resource dependence of these people is neither traditional nor of subsistence nature. The area has to be sealed and isolated from the vast sea of people to conserve it as a green lung and carbon sink for entire capital city of Delhi. Looking at the size and diverse nature of people living in the immediate vicinity of the PA, no eco-development activities are possible for planning and implementation. The only program that is possible is educating the people and winning them over in favor of the management through NGOs, University and college students etc. To convert tree planting activity into a mass campaign involving active participation of Residential Welfare Associations, NGOs, Government & Semi Government organization, schools in a concerted and co-ordinated manner "Eco Task Force" has been constituted. The recommendation of this committee needs to be initiated two months in advance of the monsoon season. Free distribution of seedlings, to public, Govt. deptt. and institutions to be taken up in each range.

CHAPTER 9

RESEARCH MONITORING AND TRAINING

Research and monitoring are usually among the weakest links in wildlife management. The practical interpretation is that the management of PA needs information which can be generated through proper investigation or research and documented in the form of data bank for reference and use as and when required.

9.1. Research

Research needs to be interpreted in a broad sense that includes management intervention experiments. Priorities need to be recognized on a scale of importance. For proper management it is necessary to have a basic knowledge of important factors like occurrence of flora and fauna species, distribution over the PA and population dynamics. Besides Forest Department various agencies had been working in revitalizing the biological and ecological potential of ABWLS. Kalpvriksh(1991) has documented the fauna and flora of Delhi ridge followed by Sawarkar and Hussain(1997) and Kumar and Khanna(1997), Zoological Survey of India(1997) published fauna of Delhi covering also Asola Bhatti Wild life Sanctuary.

9.1.1. Research Work Done in Past

The research activities can be categorized into fundamental research and strategic or management oriented research. Some of the research done in past are as follow-

1. Kumar & Khanna (1997) published a fauna profile of ABWLS based on the work of Kalpavriksh (1991), Sawarkar and Hussan (1991) and Zoological Survey of India (1997). The comprehensive and updated faunal profile provided incorporated inventory of 246 spp. of fauna including 35 spp. from invertebrates and 2 spp. of Amphibia, 3 spp. of Reptile, 196 spp. of Aves and 10 spp. of Mammalia from vertebrata.
2. The research team from ZSI lead by Dr. N.K. Sinha (1997), Dr. S.K. Gupta (1998), Dr. Vinod Khanna (1998) and Sh. J.P. sati (1999) came out with additional record of 64 more spp. which include 44 spp. from invertebrate and

3 spp. from pisces, 3 spp. of Amphibia, 4 spp. Of Reptilia, 2 spp. of Aves and 8 spp. of Mammalia from vertebrata.

3. A check list of Mammal published by Director ZSI as occasional paper no. 199: 1-289 (2002) and prepared by Alfred, J.R.B, Sinha N.K. and Chakrborty S. (2002).
4. Research study under taken by Mahashman J.K. (1963) leading to the publication of the flora of Delhi (1-947) CSIR New Delhi.
5. A research note presented by Kalpvriskh (1-49) New Delhi (1991) titled 'The Delhi Ridge Founts Decline and conservation'.
6. Research study undertaken by Sawarkar V.B. and Uniyal V.K. (1995) from Wildlife Institute of India, Dehradun for preparation of Management Planning of Asola-Bhatti WLS.

9.1.2. Future Research Strategies

Fundamental research is not of much importance for Asola-Bhatti Wildlife sanctuary. However some of the strategic research topics are proposed below. Since the PA have very skeleton staff and all are un-trained in wildlife management, therefore it is proposed to take up the research works by expert agencies on contractual and funding basis. Various organizations like Wildlife Institute of India (W.I.I.) Dehradun, Forest Research Institute (F.R.I.) Dehradun, Botanical Survey of India, Bombay Natural History Society (B.N.H.S.) and even specialized NGOs can also be contacted to take such works. The DCF or the Chief Conservator of Forests concerned may propose these research topics to relevant institutes.

Research on following topics would be of immense use for evolving future management strategies of the sanctuary.

S.No.	Research topic proposed
1	Case study of secondary succession in Asola-Bhatti including that in mining pits.
2	Importance of PA as carbon sink and green lungs of capital city of Delhi-Faridabad-Gurgoan urban conglomeration.
3	Assessment of present level of human pressure affecting the optimum capacity of the PA to perform above functions.
4	Assessment of carrying capacity of the PA for rehabilitation of monkeys and prescribing population control protocol for them.

5 Few case study on filling of mined pits and habitat development for ungulates.

9.1.3. Research infrastructure

Some field equipments like Global Positioning System (GPS), High Precision camera, Altimeter, Pedometer should be procured and provided to field staff for collection of data from field. Computer with accessories should be provided to Range officer. A data base for different information pertaining to the PA needs to be created at Range Office/Division office level.

9.2. Monitoring

Management prescription applied in field need proper monitoring to help and evaluate their success or failure. The monitoring parameters need to be identified and analytical approach must be laid down. Following monitoring issues are proposed:

1. Monitoring changes in wildlife population
2. Monitoring change in vegetation species composition and vegetation type.
3. Monitoring invasion of weeds and climbers
4. Monitoring of Health and Disease of wild animals
5. Monitoring of Water regime

9.3 Monitoring Wildlife population

A base line data for Nilgai and peafawls has been created in the current management plan. The population should be monitored every third year. The status of small mammals, nocturnal animals should be studied to assess their numbers which should than be monitored once in three years. The bird check list needs to be updated at regular intervals. A check list of butterflies, fishes, amphibians and reptiles also needs to be prepared. A constant monitoring of population of rehabilitated monkeys will be necessary along with monitoring the population control methods for monkeys.

9.4 Training

Staff of Protected Area is involved in a variety of activities like protection, interpretation restraining of animals besides highly specialized job of routine reporting about happenings inside the forest. The front line staff of ABWLS is also involved in other development works of forest department under Delhi Administration

as there is no separate staff earmarked for the PA. All these duties assigned to forest staff are technical and need skill up gradation from time to time. The already trained staff can also act as resource person for lower level staff. Such training also tend to elevate the moralc of staff and take them away from the monotony of their routine job. By looking at the qualification of the staff, it is easily understandable that staffs of the PA are not even trained in basic forestry. Therefore, after imparting training in the regular Foresters and Forest guards courses, following on the job training courses are prescribed at regular intervals for front line staff to increase the management capability of Asola Bhatti WLS staff.

1) Protection duties including use of firearms, survey and demarcation, fire fighting and intelligence gathering network.
2) Tourism management including interpretation and conservation education, conducting nature camps and creating awareness among people.
3) Census of wild animals, grassland ecology and management, water source management, animal diseases, habitat improvement works etc.
4) Tranquilization, rescue and veterinary care.
5) Application of laws and regulations.
6) Post mortem of wild animals and other wildlife health care.
7) Post Graduate Diploma courses in wildlife management at W.I.I., Dehradun for A.C.F. and D.C.F.
8) Wildlife health, chemical immobilization, application of power fencing etc. at W.I.I. for Range Officers and Beat Officers.
9) Certificate courses in wildlife management at W.I.I., Dehradun for Range Officers.

CHAPTER – 10

ORGANISATION AND ADMINISTRATION

The administration is the main tool for achieving the goal of conservation objectives of the Sanctuary. For effective management and implementation it needs to identify the right person at all level so that high standards of management can be achieved.

10.1 General

Asola-Bhatti WLS is under administrative control of D.C.F South, who also looks after protection and management of reserve forests. Under DCF south there is only one sanctioned post of Range Officer. Large number of vacancies of field staff exists, as a result of which the protection and management works are adversely affected. It is learned that one of the problem of filling up vacant posts is due to absence recruitment rules for forest guards and foresters. The issue needs to be resolved urgently.

10.2 Objective

1. To have suitable administrative Structure
2. To provide efficient protection measures
3. Improve Human resource development

10.3 Problems

1 There is only one sanctioned post of Range Officer who looks after the management of the sanctuary as well as reserve forests under South Delhi Division.

2 Large number of vacancies exists at the division level. One of the reasons for these vacancies to remain as such was stated to be the absence of recruitment rules at the government level.

3 The average age of existing field staff is Staff is high which indicates that no recruitment has been done since long. It is difficult to obtain desired protection output from such over aged and meagre field staff.

4 Monkey rehabilitation on such large scale in the PA will also need veterinary advice for population control and checking disease spread in the PA and as well as outside the PA .

10.4 Existing Staff Position

The existing staff position under the South Delhi Division is as follows:-

S.No	Name of the post	Pay Band	No. of Posts sanctioned		No. of posts filled up		No. of vacancies
			Regular	Contract	Regular	Contract	
1.	Dy. Conservator of Forests	15600-39100	1	-	1	-	-
2.	Forest Ranger	9300-34800	1	-	1	-	-
3.	Dy. Forest Ranger	5200-20200	4	-	3	-	1
4.	UDC	5200-20200	1	-	1	-	-
5.	LDC	5200-20200	3	-	3	-	-
6.	Driver	5200-20200	2	-	1	-	1
7.	Mali	5200-20200	2	-	1	-	1
8.	Patwari	5200-20200	1	-	1	-	-
9.	Forest Guards	5200-20200	19	-	11	-	8
10.	Labours	5200-20200	202	-	168	-	34
11.	Consultants (Estt. & A/cs)	Consultation Fee i.e.last basic pay pension	-	2	-	2	-
12.	DEO	@Rs. 5500/- (Fixed)	-	2	-	2	-

10.5. Strategies

The Strategies are to be adopted at policy and management level. Some of the proposals are as follows:

10.5.1 Filling of the posts of Field Staff

The vacancies as shown above are to be filled up immediately by initiating the process of recruitment. Similarly the other existing posts also need to be filled up.

10.5.2 Creation of Additional Post

In the present administrative set up there is no post of foresters. The post of forester offers promotional avenues for the forest guards. Forester can help the Range officer in technical matters and can also be a supervisory officer for Forest generals. Looking at the quantum of distribution any curb on illegal activities is likely to lead to litigation. A Forester can competently handle legal cases and their enquiry. Two posts of Foresters as section officer one each fall Asola-Bhatti WLS will be enough to begin with. One post of Forester with science background may be created for looking after the eco education programme and coordination of research work by different agencies. It will be difficult to justify a separate post of veterinary doctor but arrangement can .... Be worked out with same private veterinary doctor for the purpose started above. One post of Forest ranger will be needed in addition to the existing part of Deputy Ranger. Forest Ranger can be the in-charge of the PAs where as the Deputy Ranger can look after the monkey rehabilitation independently. It is also proposed to create a new post of Range Officer especially to manage the WLS. Proposal for creation of posts is as under:-

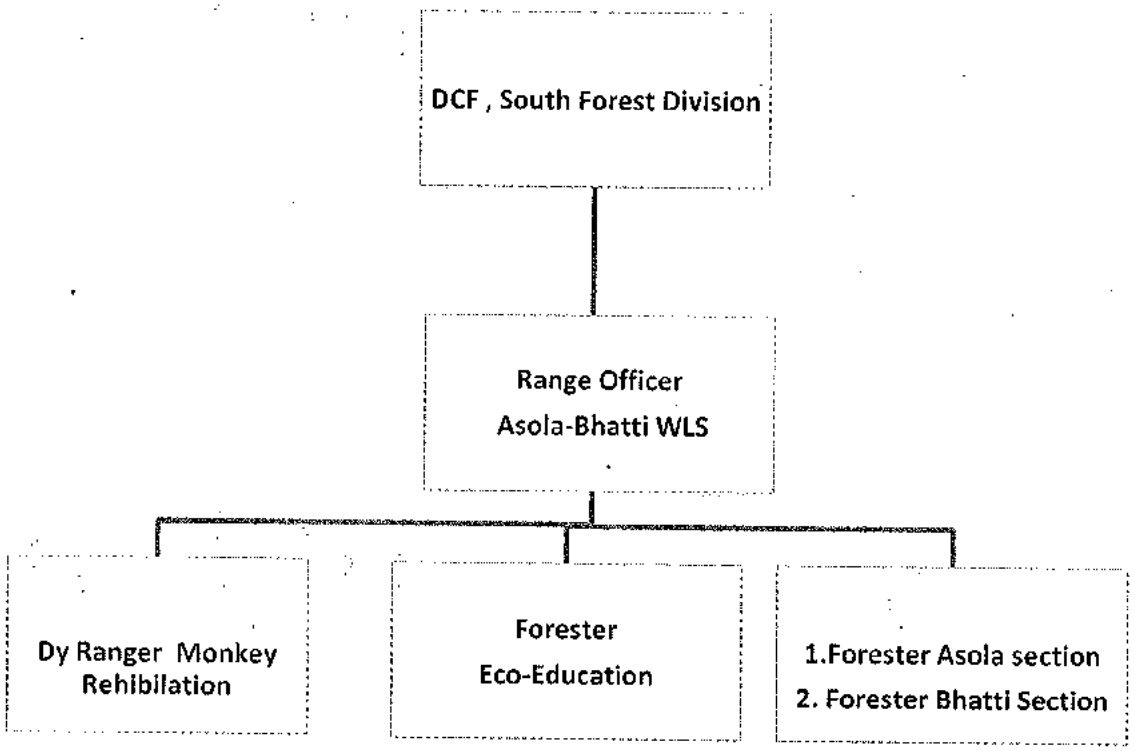
Sl. No	Name of Post	Pay Band	Nos post proposed for creation	Remark
1	Forest Range Officer	9300-34800	1	Creation of new post
2	Forester	5200-20200	3	Creation of new post
3	Forest Guard	5200-20200	4	New post

10.5.3 Re-organization of Beat Boundary

Currently the sanctuary has no beat system. This should be formalised with demarcation on the ground and on maps. Currently, the sanctuary does have a loose system of beats. This should be formalised with demarcation on the ground and on maps. The protection of each beat must be the responsibility of specifically assigned Guards whose work should be supervised by beat officers and then by the Range officer in an ascending order of hierarchy as already established within the forest departments. Each member of the field staff should have a cut and paste type

topographic map, specially of his own jurisdiction. Thus Guards must carry their respective beat maps, enlarged to the scale (1:8000). Each map should have super scribed feature, such as roads, location of pits, of plantation areas, water sources, sections of the protective wall, and administrative or management units such as nature trail, all important locations and features connected by trail etc. It should not be difficult to develop a framework of compartments by using topographic features and assigning each unit a serial number. This framework should first be developed on a topographic map and then demarcation features be established in the field, which mostly will be natural and where necessary, dry rubble cairns could be established with serial nos. Thus any event or activity can be tied down to locations on the ground. Such a framework needs no justification, neither any elaboration as regards its utility. This is a standard approach followed by the state forest departments. A compartment constitutes the smallest unit of management on spatial scales.

10.6 Organizational/Administrative set up Chart: The proposed administrative set up for Asola Bhatti WLS is as follows:-



10.7 Staff Amenities

A) **Housing:** - The field staff should be provided with reasonably good accommodation at the nearest range headquarter.

B) **Vehicle:** - Patrolling remains one of the main activities in WLS management. For mobility, Range officer should be provided with a four wheel vehicle. Dy FR and Forester should be provided with motorcycle. The staff not provided with vehicle should be provided with transport allowance.

C) **Communication:** - As there is no wireless communication in the Sanctuary, it will be necessary to provide mobile phones to all field staff.

D) **Uniform:** - Wearing of uniform culture in field staff is lacking. Each year uniform should be provide to field staff. Washing allowances should also be provided to them.

E) **Incentives and awards:** - Awards and incentives for meritorious services are moral booster particularly in wildlife area. This sets example for others to emulate.

F) **Promotional Opportunity (Policy level):-** Delhi state forest department do not have its state forest manual. Likewise there is no hierarchical set up like other states. Field forest staff when compared with other states they find themselves deprived of promotional avenues. The matter needs to be taken up at policy level so that staff promotion avenues are created.

CHAPTER – 11

THE BUDGET

11.1 The budget refers to the amount required to operate the management plan strategies prescribed in the foregoing chapters. The budget provision has to be made as per CPWD schedule of rates. The exercise needs to be based on realistic estimations and careful calculations including wage enhancement and price hike. Fund remains a constraint and therefore management is given the liberty to prioritize the works as per fund. Proposal from Central Government under (Plan) Integrated Development of Wildlife Habitats can also be sought for in case of shortage of fund from state Plan.

Sl. No	Description of work	Physical target	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
1.	**Restoration of Habitat** Fruit bearing plantation											
a)	Advance Nursery @1100/-ha											
b)	Creation@113 dls/-ha@Rs120											
d)	Tending 2nd year@39dl/-ha											
e)	Tending plantation 3rd. year@17 dls											
f)	Maintenance of central Nursery including rising of additional 50,000 seedlings for free distribution.											
g)	Construction of trench cum mound	2 km per year										
h)	Maintenance of TCM	2 km per year										
2.	**Water Management for Wildlife & irrigation**											

a)	Purchase of silent DG set, self starting cable etc. including installation of pump (3X10HP)											
b)	Laying of PVC pipe 400 RM with hose pipe etc.											
c)	Maint. of water hole constructed in past.		1.50	1.55	1.60	1.65	1.70	1.75	1.80	1.85	1.90	1.95
d)	Purchase of water tanker.											
e)	Soil and moisture conservation by construction of check dams.	2 Nos each yr	4.20	4.30	4.40	4.50	4.60	4.70	4.80	4.90	5.00	5.10
3.	**Anti poaching squad(Protection)**											
a)	Engagement of ETF for protection duty (salary component)											
b)	Logistic support to Anti poaching squad like torch, battery, uniform etc.		0.50	0.60	0.70	0.80	0.90	1.0	1.10	1.20	1.30	1.40
c)	Construction of temporary protection camp of containers (size 20ft X 8ft)	1 each yr	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.10	3.20	3.30
d)	Vehicle – purchase of vehicle (LMV) Maruti Gypsy		6.00	-	-	-	6.50	-	-	--	7.00	--
e)	Purchase of motorcycle	2 Nos each yr	1.10	1.10	1.20	1.20	1.30	1.30	1.40	1.40	1.50	1.50
f)	Maint of vehicle for patrolling duty including Fuel	LS	1.60	1.70	1.70	1.80	1.80	1.90	1.90	2.00	2.00	2.10
g)	Construction of check	-	-	2.50	-	-	3.00	-	-	--	3.50	--

	gate											
h)	Maintenance of check gate	LS	0.40	0.40	0.50	0.50	0.60	0.60	0.80	0.80	0.90	0.90
4.	**Fire protection**											
a)	Construction of fire lines	5 km/yr										
b)	Maint of fire line											
5.	**Patrolling Path**											
a)	Construction of patrolling path	5 km/yr										
b)	Maint. of old patrolling path	5 km/yr										
6.	**Construction of Buildings**											
a)	Construction of type IV											
b)	Construction of type III											
c)	Construction of type II											
d)	Construction of type I											
e)	Maint of buildings											
f)	Construction of Range office building											
g)	Construction of Vetenery hospital											
h)	Construction of rubble masonry boundary wall	2 km/yr										
i)	Maintenance of boundary wall	5 km/yr										
7.	**Wildlife Health**											
a)	Health checkup of primates including castigation											
b)	Providing Mineral salt Block		0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	1.00
8.	**Human Resource**											

	Development											
a)	Capacity building to field staff		2.00	2.00	2.20	2.20	2.40	2.40	2.60	2.60	2.80	2.80
b)	Staff welfare Amenities like medicine, mosquito net , solar lamp, torches etc. for protection camp		1.50	1.50	1.60	1.60	1.70	1.70	1.80	1.80	1.90	1.90
9.	**ECO TOURISM**											
a)	Construction of interpretation centre at Bhatti		--	100.00	--	--	--	--	--	--	--	--
b)	Theme based display of interpretation material by WII		--	--	50.00	--	--	--	--	--	--	--
c)	Interactive touch screen display		--	--	--	10.00						
d)	Artistic signages at entrance (two locations)		--	5.00	--	--	--	--	5.50	--	--	--
e)	Library with reading room		5.00	--	--	--	--	--	--	--	--	--
f)	Construction of iron railings along selected pits.		3.00	3.00	3.00	3.00	--	--	--	--	--	--
g)	Construction and development of birds trail		6.00	--	--	--	--	--	--	--	--	--
h)	Construction and development of butterfly walks		--	--	--	--	6.00	--	--	--	--	--
i)	Construction and development of tree walks		--	--	--	--	--	--	6.00	--	--	--
j)	Construction and development of Medicinal plant walks		--	--	--	--	--	--	--	--	6.00	--
k)	Awareness message of		2.00	2.00	--	--	--	--	--	2.50	2.50	--

	rock surface inside WLS											
10.	**Awareness and Publicity**											
a)	Observation of wildlife week		1.00	1.00	1.10	1.10	1.20	1.20	1.30	1.30	1.40	1.40
b)	Observation of Van Mahotsva		1.00	1.00	1.10	1.10	1.20	1.20	1.30	1.30	1.40	1.40
c)	Awareness Campaign/ Nature Camps for schools	Ls	0.50	0.50	0.60	0.60	0.70	0.70	0.80	0.80	0.90	0.90
11	**Research and Monitoring**											
a)	Purchase of computer with Printer and	LS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
b)	Census of Major wild life Species once in two years	LS	--	1.50	--	1.50	--	1.60	--	1.60	--	1.70
c)	Purchase of equipments like GPS, Binoculars etc.	LS	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--

CHAPTER 12

THE SCHUDULE OF OPERATIONS AND MISCELLANEOUS REGULATIONS

12.1. The Schedule

The schedule of operations drives management interventions in a series of ordered annual tasks. It details the annual physical targets and corresponding financial allocations reflected in the budget. The various prescriptions proposed in the management plan have been given in detail in the respective chapters. On the basis of these prescriptions the annual plan of operation could be prepared by the DCF South Division for which budgetary provisions can be made and on approval item of works can then be carried out. According to budget provision, preparation of advance plan of every year will facilitate making of budget provisions and sustainable planning as per requirement of Management Plan. The items of work that cannot be completed in a particular year due to lack of budget provision or late receipt of budget could be carried forward in the next year's plan of operation.

12.2 Record of Deviations and Implemented Targets

The record of deviations from the Management plan prescriptions needs to be maintained. At the time of revision of the management plan these deviations need to be referred to especially on matters which relate to strategy in the field. The record of deviation statements are usually not maintained properly. The management should ensure that the deviation statements maintained properly as per prescription of management plan.

12.3. The Record of Employment Potential

It is important to know the man-days created in a financial year for different works. This not only gives the employment generated by sanctuary but also gives the expenditure incurred against each theme/work in a given month and accordingly the total wage component sized during the year. The concerned Range Officer should thus maintain a register for such labour generation in different schemes in the Performa shown at Table.

Table 12.1: Record of Employment Potential

Sl.No.	Name of Range	Month	Nature of work	Total No. of man days generated	Approx expenditure	Remarks
1	2	3	4	5	6	7

12.4 Control Forms

There are 18 principal control forms. These together with their sub-units constitute a total of 51. All follow in their appropriate order. At the end of each financial year all the control forms are to be posted. To facilitate in posting of information, each range should maintain register. Now a days when computers are available at the range level, then this task of updating information in control form is much easier. The list of control forms are enclosed at Annexure....

12.5 Maintenance of Compartment Histories

Maintenance of compartment history is a well defined practice in the management of forests. Unfortunately this practice is not being given due importance in management of wildlife and is found lacking in most cases. The compartment history is an important document and should be maintained.

Habitat Suitability Map for Nilgai **Map No 8**

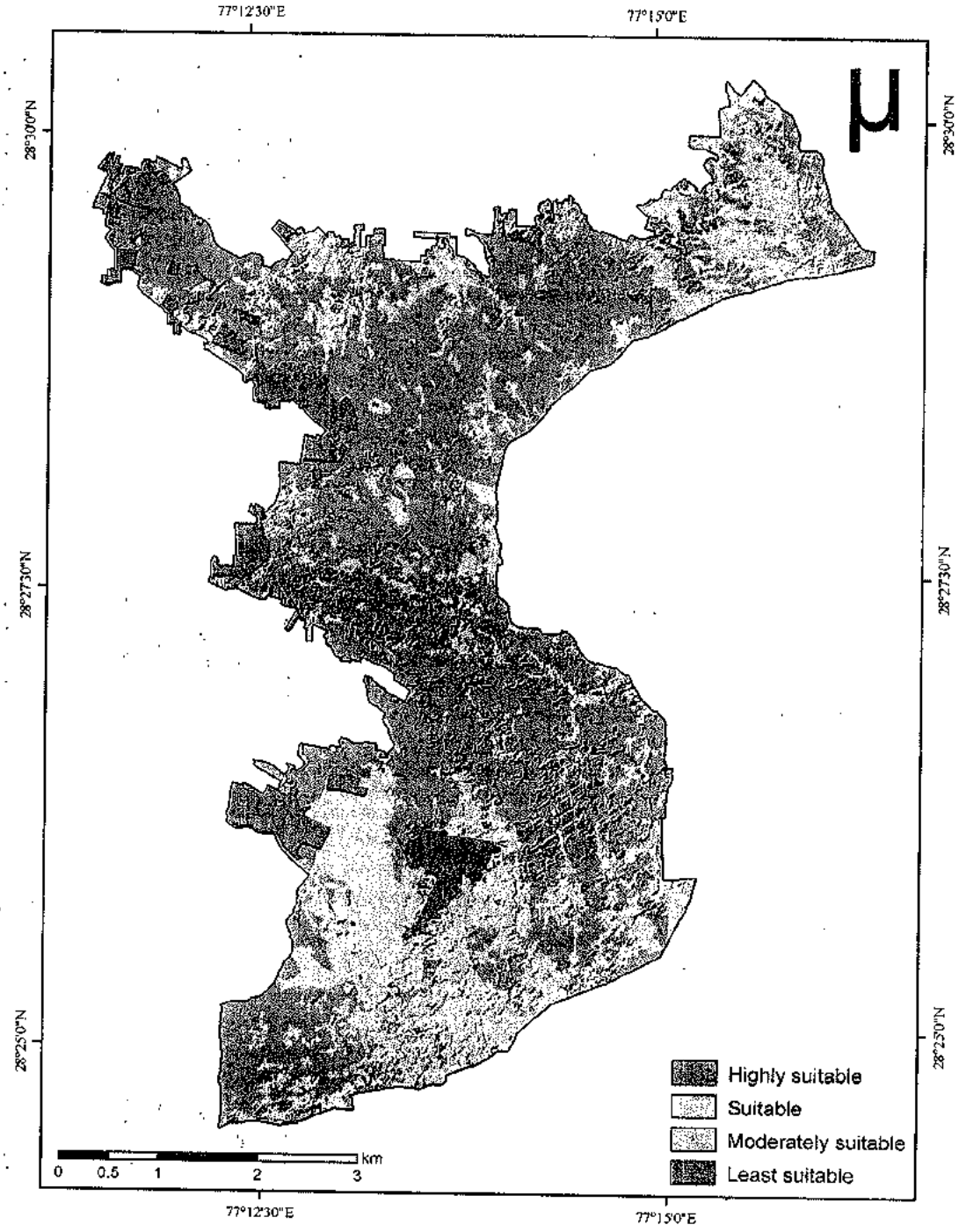
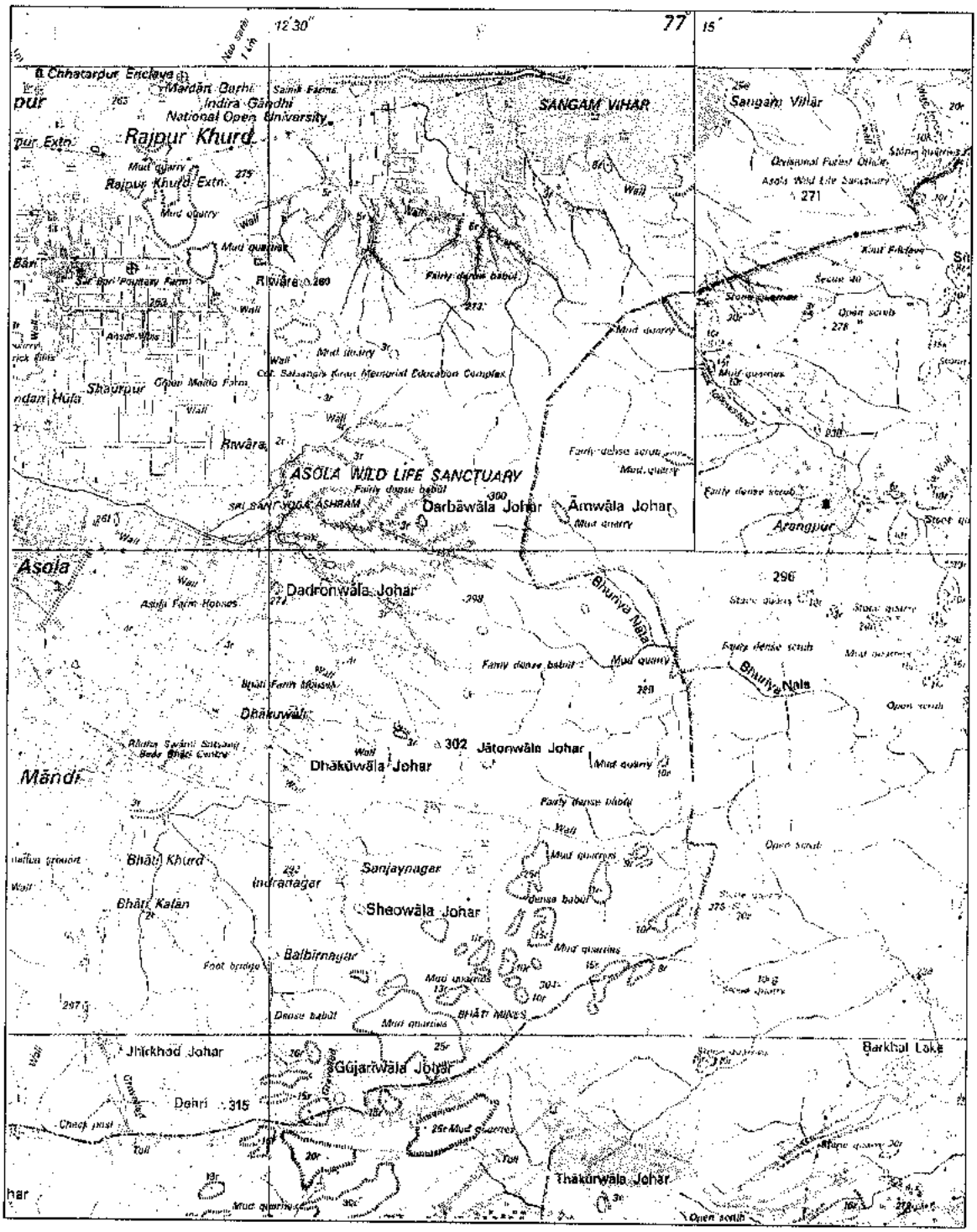


Fig.: Habitat suitability map.

Zone Plan Map

Map 1



Communication Map of AB WLS - **Map No 2**

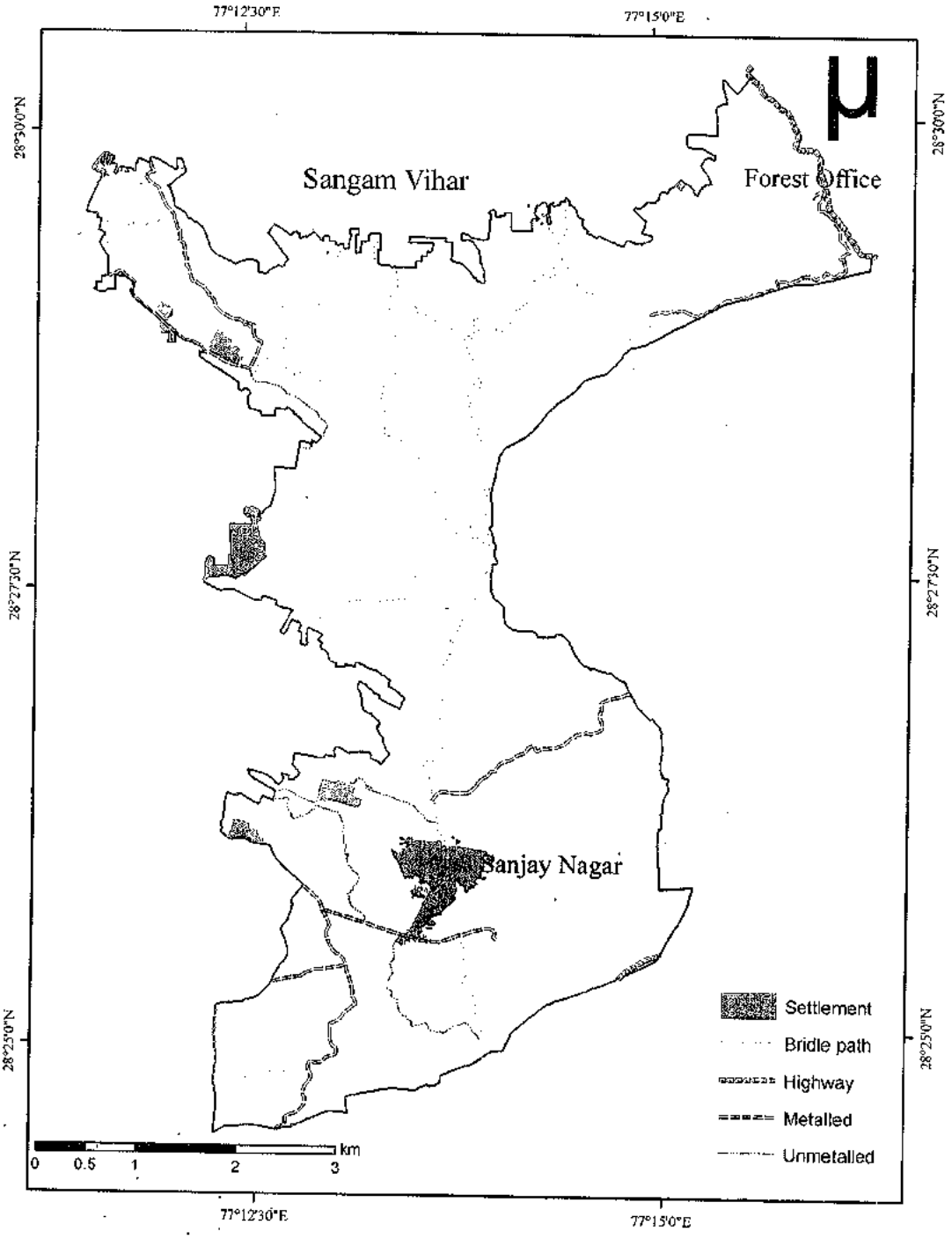


Fig. : Communication Network Map.

Drainage- Water Body Map - **Map No 3**

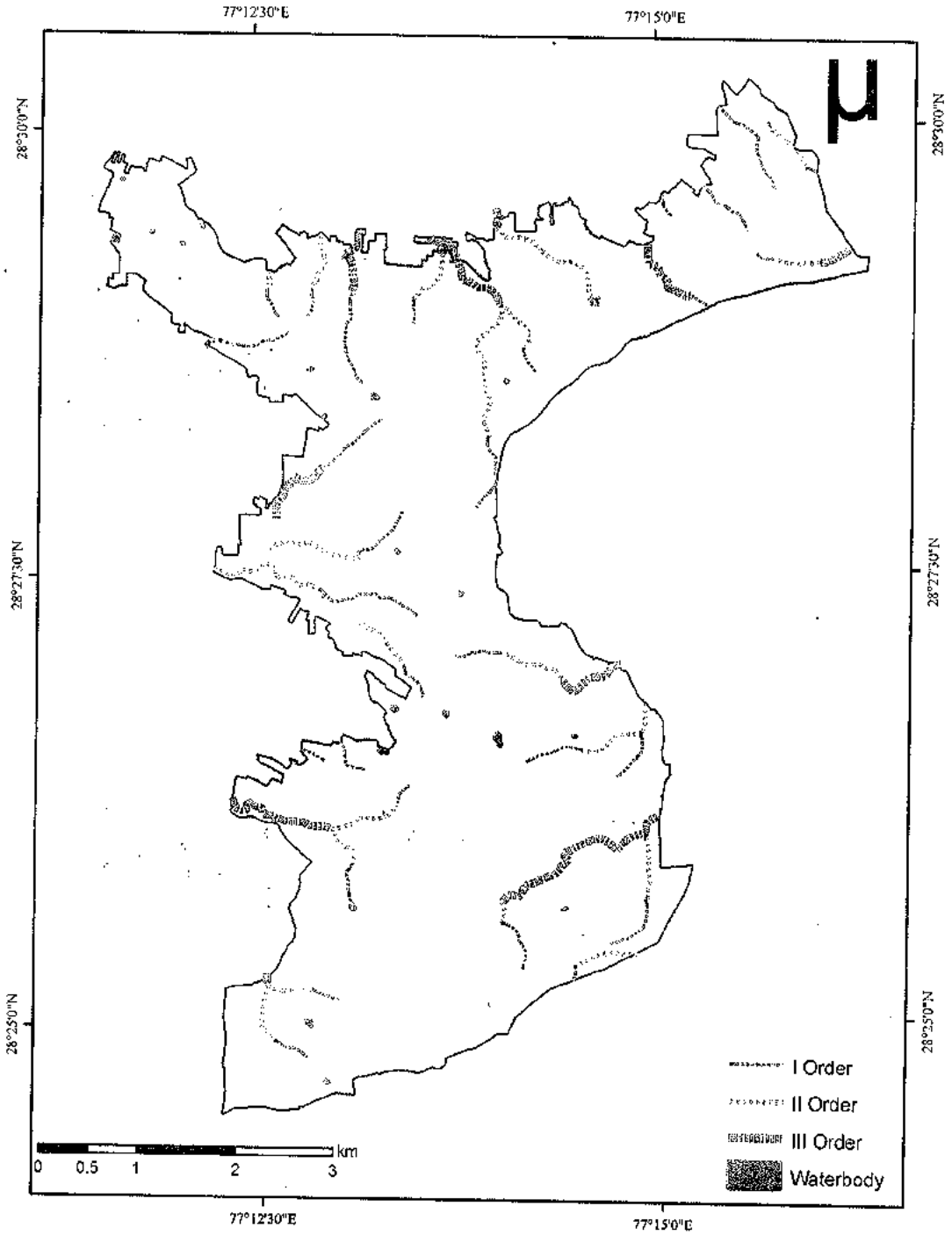
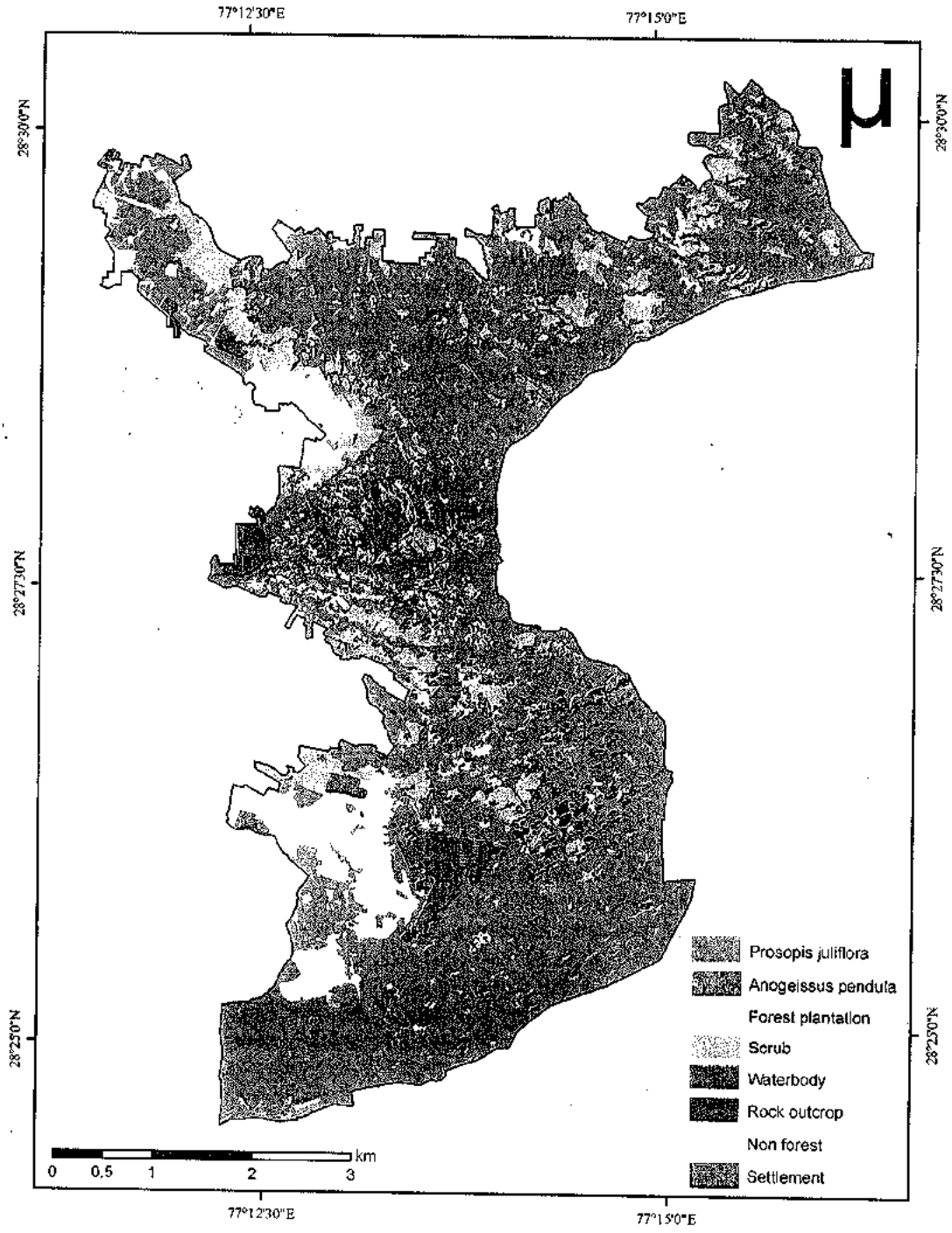
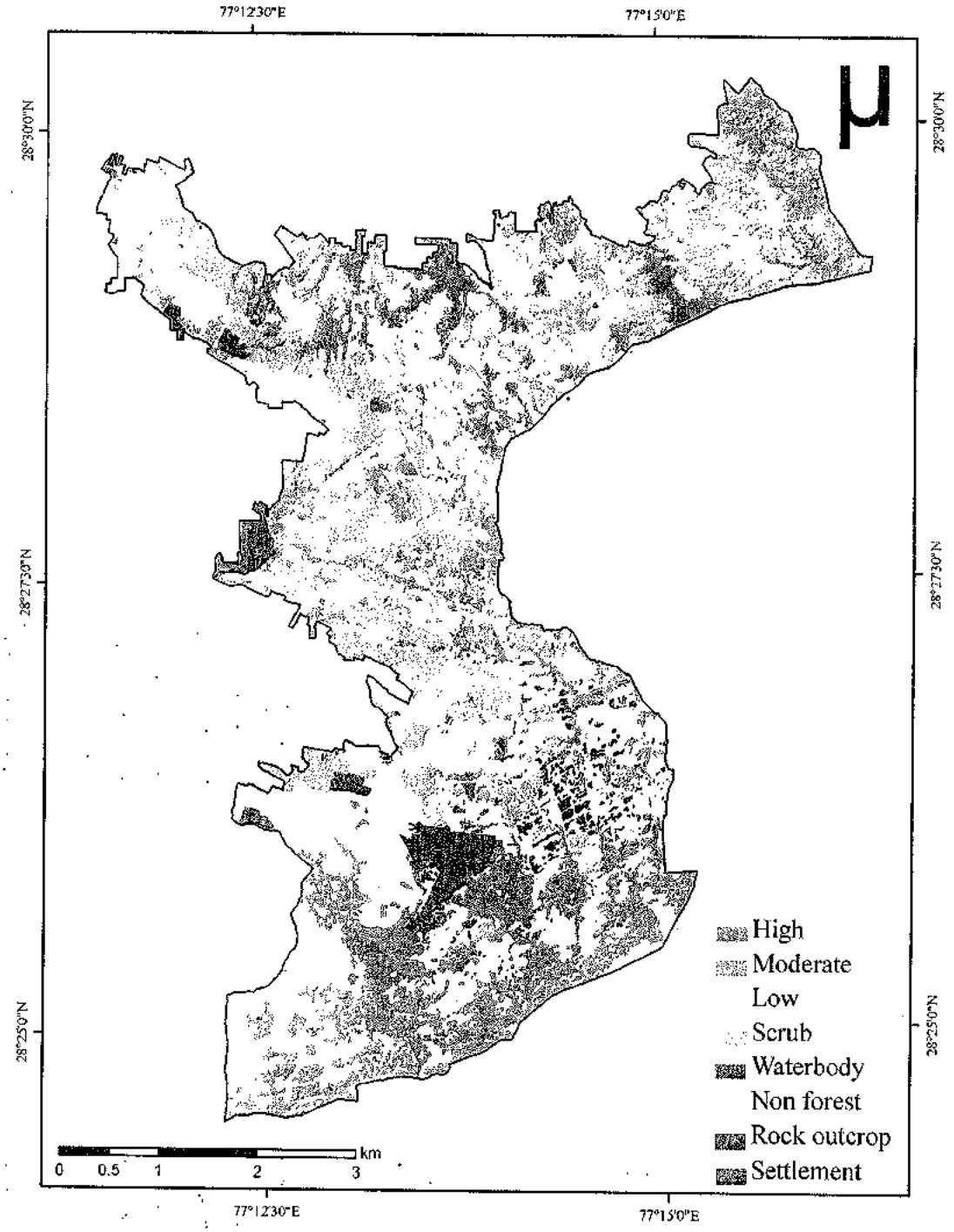


Fig. : Drainage-waterbody map.

Land Use/Land Cover Map - Map No 4

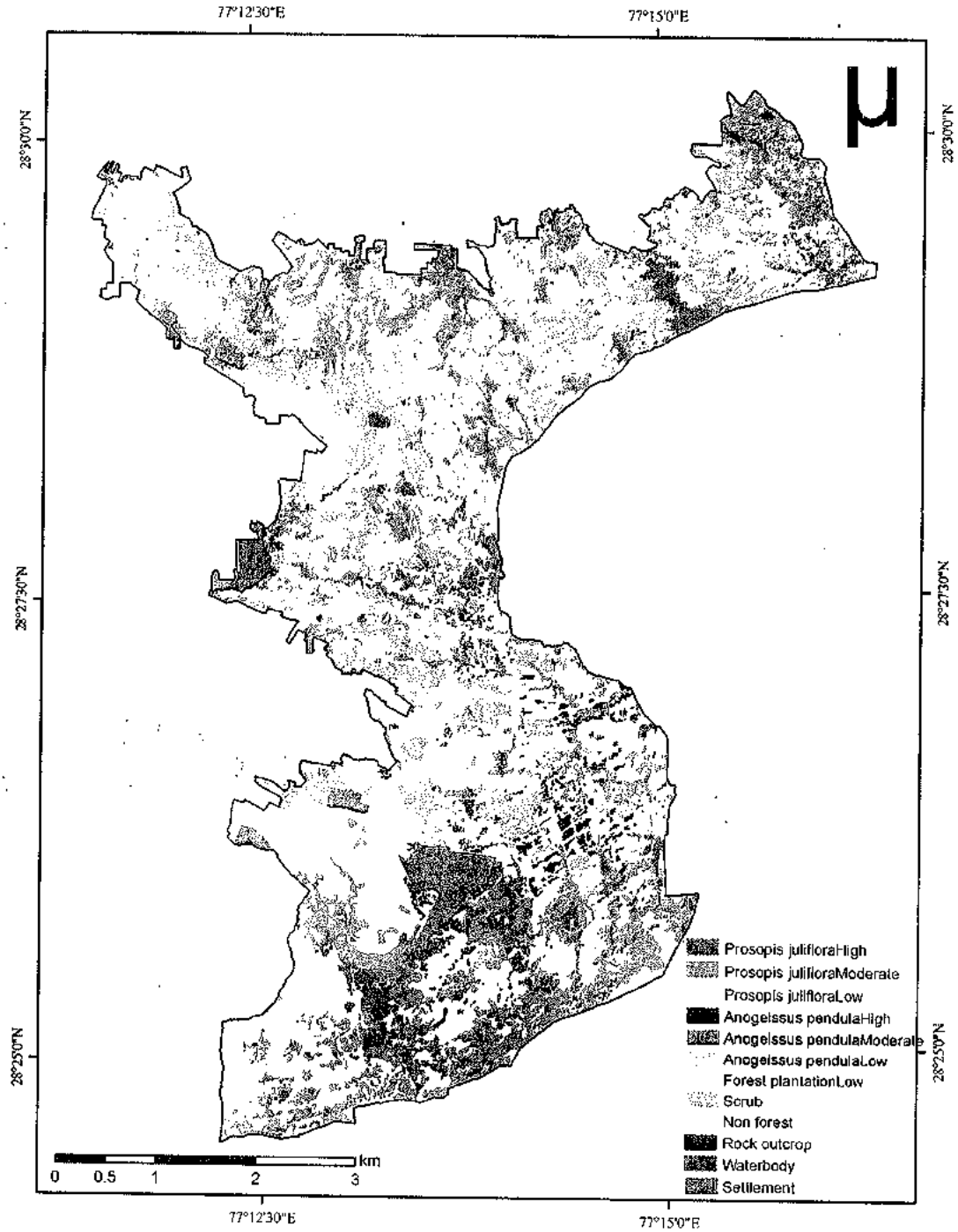


Forest Density Map - **Map No 5**

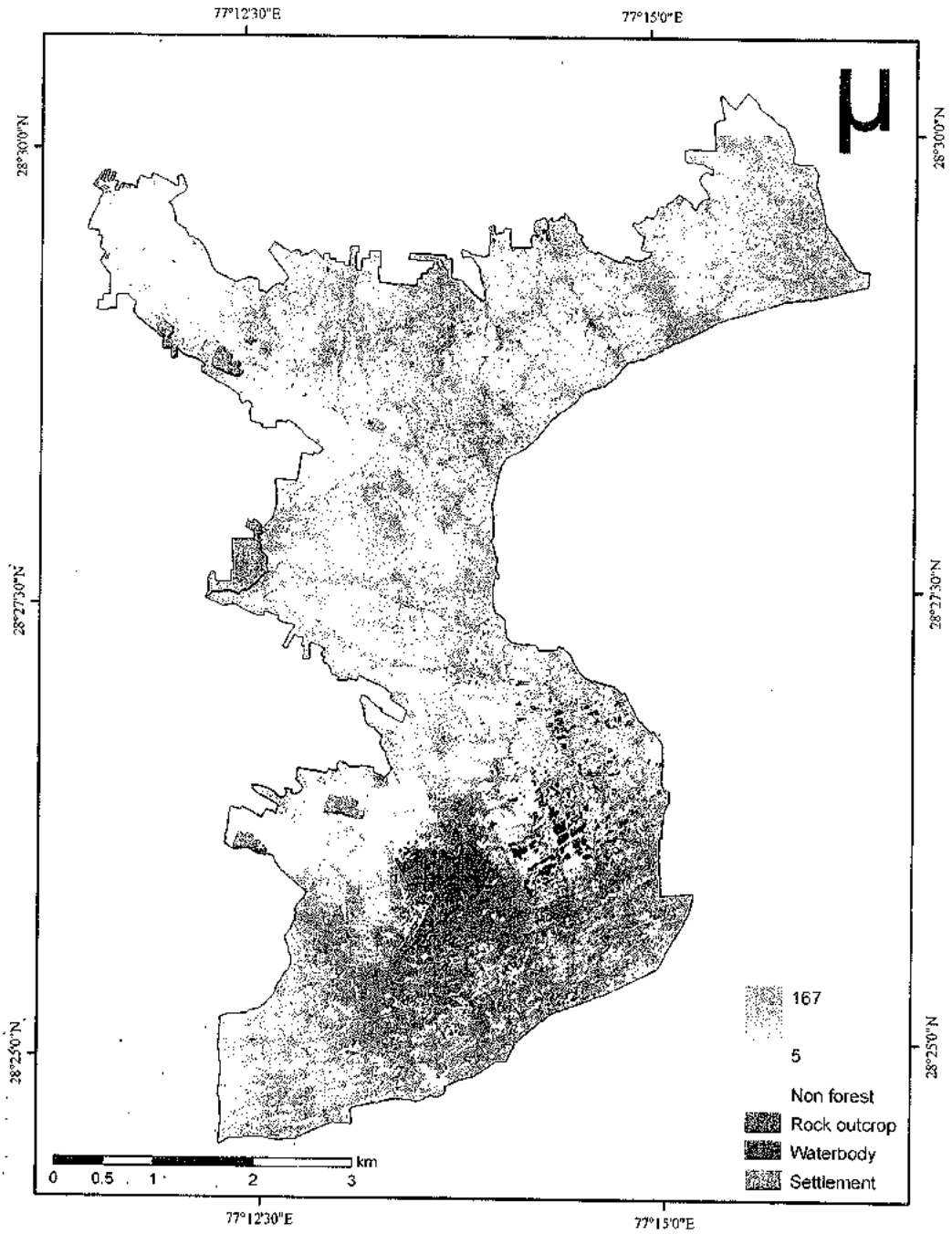


Vegetation type density map

Map No 6



Growing Stock Map **-Map No7**



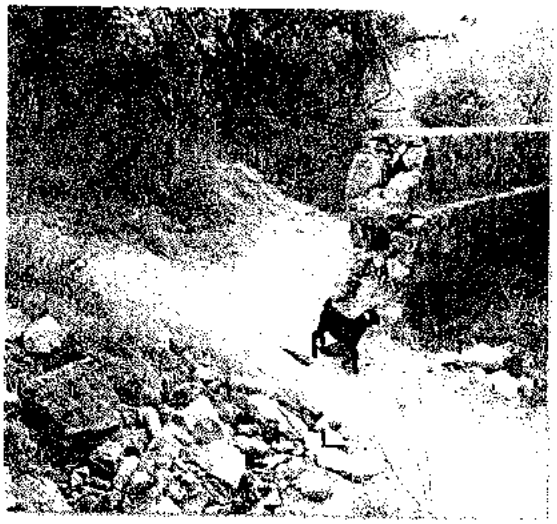
IRS-P6, LISS IV and Cartosat Merged Satellite Data (Dt. 16.12.2010)

Geology, Rock Soil & Biotic Pressure on WLS

Geological composition of rocks

Soil composition reddish appearance

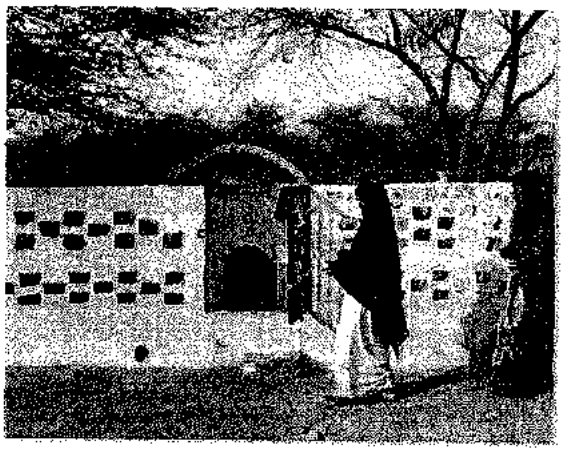
Sanjay Nagar colony inside WLS



Tress passing through broken wall

Cattle grazing inside WLS

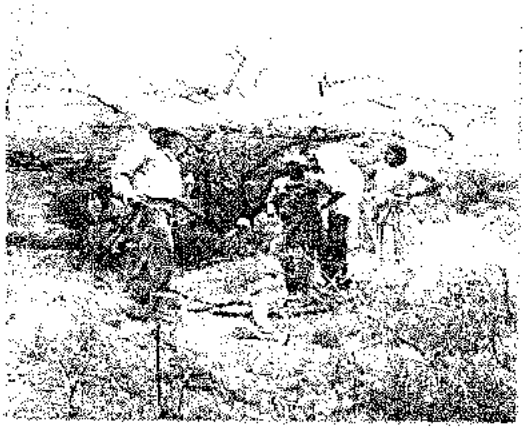
Browsing by goats



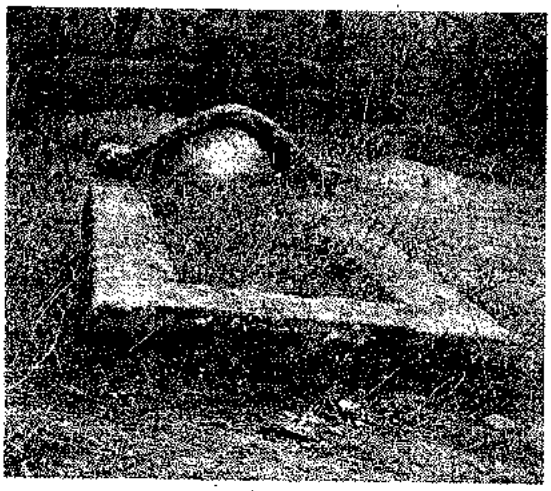
Peer Baba Mazar inside WLS

Tree felling

Dumping of waste inside WLS



Fuel wood collection inside WLS



Graveyard

Playground inside WLS

Annexure III

Monthly Total Rain Fall Data of New Delhi

(Safdarjung station)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	14.6	14.7	5.2	36.3	77.9	128.3	129.7	233	47.4	6.6	0.0	0.0
2002	20.7	16.8	2.6	0.6	129.3	48.4	7.2	115	202.6	1	0.0	16.8
2003	38.5	27.9	5.0	0.9	6.0	164.2	632.2	156	100.2	0.0	0.0	30.2
2004	16.1	0.0	0.0	67.5	37.7	72.5	13.8	275	3	89	0.0	0.0
2005	3.4	47.6	33.8	4.5	4.2	69.2	193.9	132	231.6	0.0	0.5	0.0
2006	0.9	0.0	25.3	2.4	57.3	124.3	313.3	98	129.6	3.4	0.0	3.2
2007	1.7	76.2	61.6	0.4	71.5	134.3	163.1	214	85.6	0.0	1.8	0.0
2008	1.8	3.1	0.0	38.6	165	91.6	146.2	311	154.4	0.0	0.0	0.0
2009	5.8	4.7	9.6	3.2	65.8	19	161.2	217	191.2	5.4	10.4	2.8

Annexure IV

Monthly Maximum & Minimum Temperature Data of New Delhi

(Safdarjung Station)

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	Max	19.7	25.3	30.4	35.8	38.8	35.7	34.7	35.2	36.3	34.2	29.4	23.6
	Min	66.6	9.8	14.9	21.1	26	26.5	27.6	26.9	25.1	19.9	12.7	8.9
2002	Max	20.7	3.9	30.8	38.3	40.9	39.2	39.4	34.6	32.5	33.3	28.2	24.1
	Min	7.4	9.9	15.9	22.4	26.7	28.6	30.6	27.2	23.7	19.8	13.1	8.6
2003	Max	17.6	23	29.4	37.6	39.7	40.1	34.1	33.7	32.7	33	28.3	20.9
	Min	6.5	11	15.5	22	25.3	28.8	26.2	26.8	25.2	18.2	11.7	9.8
2004	Max	18.6	25.3	33.4	38.1	39	37.7	38	33.7	35.4	31.3	28.6	23.2
	Min	8.3	10.4	17.2	23	26	26.7	28.4	26.2	25.1	19	12.8	9.4
2005	Max	20.1	23.2	30.4	36.3	39.5	40.3	34.2	35.7	33.9	33.2	29	22.7
	Min	7.7	10.8	17.1	20.4	24.8	28.2	27.1	27.3	25.1	18.8	12.2	6
2006	Max	22.4	29.7	29.6	37.4	39.8	38.2	34.9	35.5	34.5	33.6	28.9	23.3
	Min	7.1	13.5	15.2	20.1	24.5	24.3	27	26.8	24.7	20.5	13.9	9.3
2007	Max	21.5	24.2	28.3	38.2	38.9	38.1	35.9	35.1	34.6	33.4	29	22.9
	Min	6.8	11.8	15.3	23	25.8	28.4	27.6	27.2	25.2	17.5	12.6	8
2008	Max	20.9	23.5	33.4	36.2	37	35	35.3	33.7	33.9	34.2	29	24.5
	Min	6.5	8.3	17.1	21.2	24.5	26.7	27.1	26.4	24.5	20.9	12.9	10.2
2009	Max	21.7	26.1	31.5	36.6	40.1	40.9	36.9	35.4	34.1	33	27.2	23.6
	Min	8.9	11.1	16.1	22.2	26	28.2	28	27.2	25.1	19.2	13.5	8.7

Annexure V

Monthly Relative Humidity (08:30 AM and 05:30 PM) Data of New Delhi

(Safdarjung station)

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	08:30 AM	88	80	65	60	61	77	81	76	65	76	71	86
	05:30 PM	61	39	35	37	37	63	69	62	48	48	53	67
2002	08:30 AM	88	81	63	42	47	61	54	82	86	77	77	83
	05:30 PM	55	46	34	20	29	41	40	70	68	54	56	65
2003	08:30 AM	93	80	65	45	38	57	85	85	84	73	76	88
	05:30 PM	67	50	35	21	22	42	70	74	68	44	46	70
2004	08:30 AM	92	84	63	48	53	66	65	84	68	81	77	84
	05:30 PM	71	40	26	29	31	45	50	72	47	52	50	58
2005	08:30 AM	87	81	76	39	39	50	82	69	81	70	71	80
	05:30 PM	54	48	39	17	20	37	70	55	65	43	42	48
2006	08:30 AM	81	80	73	43	58	61	79	77	76	73	83	85
	05:30 PM	41	37	36	20	33	44	67	62	57	47	51	54
2007	08:30 AM	93	94	95	95	54	66	77	82	80	67	86	83
	05:30 PM	47	55	43	24	35	49	66	68	62	35	57	47
2008	08:30 AM	84	81	68	51	57	78	83	84	80	78	84	88
	05:30 PM	56	42	35	22	34	33	58	66	61	43	56	56
2009	08:30 AM	91	83	70	42	51	51	73	77	80	67	80	86
	05:30 PM	55	83	33	24	34	33	58	66	62	42	56	56

Annexure VI

List of Mammals found in Asola Bhatti Wildlife Sanctuary

The list of fauna as per field survey done by Zoological Survey of India, Dehradun (1996-1999) and published reports, there are 19 Species of Mammals belonging to 15 genera 10 families and 7 orders. The list is furnished as below:-

S.No.	Scientific Name	Common Name
1.	*Boselaphus tragocamellus*	Nilgai, Blue bull
2.	*Antilope cervicapra*	Black Buck
3.	*Macaca mulatta*	Rhesus Macadne
4.	*Presbytis entellus*	Hanuman Langur
5.	*Canis aureas*	Jackal
6.	*Viverricula indica*	Small Indian Civet
7.	*Herpestes javanicus*	Small Indian Mongoose
8.	*Herpestes edwardsii*	Indian Grey Mongoose
9.	*Herpestus Smithii Gray*	
10.	*Canis hyaena*	Hyaena
11.	*Felis chaus*	Jungle Cat
12.	*Manis crassicaudata*	Indian Pangolin
13.	*Funambulus pennanti*	Northern Palm Squirrel
14.	*Hystrix indica*	Indian Crested Porcupine
15.	*Bandicoota indica*	Large Bandicoot Rat
16.	*Mus Musculus (Linnaeus)*	House Mouse
17.	*Tatera indica (Hardwicke)*	Indian Gerbil, Antelope Rat
18.	*Lepus nigricollis Fcurier*	Indian Hare, Black-napped Hare
19.	*Pipistrellus coromandra (Gray)*	Indian Pipistrelle

List of Birds found in WLS Annexure VII

Fauna of Conservation Area No. 16, *Some Selected Fauna of Asola-Bhatti Wildlife Sanctuary* : 51-60, 2003

AVES

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INTRODUCTION

A large number of publications pertaining to the birds of Delhi area have appeared in various periodicals and books (Tak and Sati, 1997). The avifauna of Delhi ridge was, perhaps, first dealt by Gaston (1978) and a checklist of 191 bird species for Delhi ridge was provided by Kalpavriksh (1991). The same checklist was used by Savarkar *et. al.* (1996) and Kumar and Khanna (1997) for their studies on Asola-Bhatti Wildlife Sanctuary (ABWLS). However, Sawarkar *et al.* (1996) made five new additions from Asola-Bhatti Wildlife Sanctuary to the existing checklist of the birds of the ridge. These five new additions were Little Grebe (*Podiceps ruficollis*), Coot (*Fulica atra*), Common Redshank (*Tringa totanus*), Painted Sandgrouse (*Petrocles indicus*) and Dusky Crag Martin (*Hirundo concolor*). The present communication is based on two field trips by the authors (10-days each during August, 1997 and December 1999). The nomenclature followed is after Ali & Ripley (1969-78). The subspecific level is included on the basis of the reported range of the subspecies. For convenience, the Handbook number has been given within parenthesis following the common name.

ANALYSIS AND RESULTS

As a result of the present study, two more waterbird species, *viz.*, Common Sandpiper (*Tringa hypoleucos*) and Blackwinged Stilt (*Himantopus himantopus*) are added from Asola-Bhatti Wildlife Sanctuary to avifauna of the ridge. This study also provides locality records for 82 species of birds sighted within the Asola-Bhatti Wildlife Sanctuary, constitutes more than 40% of the total bird species (198) reported from the Delhi ridge.

These 82 species and subspecies of birds belong to 64 genera, 32 families and 15 different orders. A family-wise analysis reveal that the family Muscicapidae (the most crowded family of the passerine or song birds) predominates (15 species), followed by Accipitridae - Hawks and Vultures (6 species), Sturnidae - Starlings and Mynas (5) Charadriidae - Plovers and Sandpipers, Hirundinidae - Swallows, Ploceidae - Weaver birds (4 each), Ardeidae -

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Herons and Egrets, Phasianidae - Phaesants and Partridges, Rallidae - Rails and Coots, Cuculidae - Cuckoos, Corvidae - Crows, Magpies and Jays, Motacillida - Pipits and Wagtails (3 each) and so on.

A two-fold status terminology, *viz.*, abundance and residential (further divisible into various subcategories) has been used to determine the status of each taxa, as tabulated below.

The abundance status of each species within the sanctuary area was worked out by considering its number of sighting (s). This reveals that out of 82 species, 23 are occasional (sighted only once), 37 uncommon (observed two to three times) and 22 common (recorded more than three times) (Table).

The residential status as given by Kalpavriksh (1991) for Delhi has been used for Asola-Bhatti Wildlife Sanctuary. This reveals that out of 82 species, 56 are resident (R), 16 migrant (M), 6 resident / migrant (R/M) and 4 still lack information on their status (-).

Species such as pond heron, little egret, red-wattled lapwing, blue rock pigeon, rose ringed parakeet, hoopoe, treepie, house crow, redvented bulbul, robin, white wagtail etc. were encountered throughout the sanctuary area during the surveys.

Indian Peafowl, *Pavo cristatus*, (the National Bird) is the only threatened bird observed in the sanctuary. It has been placed under vulnerable (Vu) category by the Red Data Book, Zoological Survey of India (1994); Schedule I of the Wildlife (Protection) Act, 1972; and the Appendix I of the Convention on International Trade in Endangered species of Fauna and Flora (CITES).

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Table-List of Birds Observed During Recent Surveys

	Status in Delhi	Abundance in AB-WLS	Localities within Asola-Bhatti WLS
I. Order PODICIPEDIFORMES			
1. Family PODICIPEDIDAE			
1. *Podiceps ruficollis capensis* Salvadori, **Little Grebe or Dabchick** (5)	R	UnCom	BMA (Dudhawali Khan), Sahurpur
II. Order PELECANIFORMES			
2. Family PHALACROCORACIDAE			
2. *Phalacrocorax niger* (Vieillot) **Little Cormorant** (28)	R	UnCom	BMA, Sahurpur
III. Order CICONIIFORMES			
3. Family ARDEIDAE			
3. *Ardeola grayii grayii* (Sykes) **Indian Pond Heron** or **Paddybird** (42)	R	Com	BMA, Pipalwala, Khajurwala, Sahurpur, Deoli, NOCA
4. *Bubulcus ibis coromandus* (Boddaert) **Cattle Egret** (44)	R	UnCom	Khajurwala, Sahurpur, Maidangarhi
5. *Egretta garzetta garertta* (Linnaeus) **Little Egret** (49)	R	Com	BMA, Pipalwala, Sahurpur, Deoli, NOCA
IV. Order FALCONIFORMES			
4. Family ACCIPITRIDAE			
6. *Elanus caeruleus vociferus* (Latham) **Blackwinged Kite** (124)	R	Occ	Deoli
7. *Milvus migrans govinda* Sykes **Pariah Kite** (133)	R	Com	Pipalwala, Khajurwala, Sahurpur, Deoli, NOCA
8. *Accipiter badius dussumieri* (Temminck) **Indian Shikra** (138)	R	UnCom	Pipalwala, Maidangarhi, NOCA
9. *Gyps bengalensis* (Gmelin) **Indian Whitebacked Vulture** (185)	R	Occ	Maidangarhi
10. *Neophron percnopterus percnopterus* (Linnaeus) **Egyptian Vulture** (186)	R	UnCom	BMA, Deoli

	Status in Delhi	Abundance in AB-WLS	Localities within Asola-Bhatti WLS
11. *Circus aeruginosus aeruginosus* (Linnaeus) **Marsh Harrier** (193)	M	UnCom	Deoli, NOCA
V. Order GALLIFORMES			
5. Family PHASIANIDAE			
12. *Francolinus francolinus asiae* Bonaparte **Indian Black Partridge** (238)	R	UnCom	BMA, Sahurpur, Maidangarhi
13. *Francolinus pondicerianus interpositus* Hartert **North Indian Grey Partridge** (245)	R	Com	BMA, Sahurpur, Deoli, NOCA
14. *Pavo cristatus* Linnaeus **Indian Peafowl** (311)	R	Com	Pipalwala, Khajurwala, Sahurpur, Maidangarhi, Deoli, NOCA
VI. Order GRUIFORMES			
6. Family RALLIDAE			
15. *Amaurornis phoenicurus chinensis* (Boddaert) **Chinese Whitebreasted Waterhen** (343)	R	Occ	Sahurpur
16. *Gallinula chloropus indica* Blyth **Indian Moorhen** (347)	R	Occ	BMA
17. *Fulica atra atra* Linnaeus **Coot** (350)	—	Occ	BMA (Bhatti)
VII. Order CHARADRIIFORMES			
7. Family CHARADRIIDAE			
18. *Vanellus indicus indicus* (Boddaert) Redwattled Lapwing (366)	R	Com	BMA, Pipalwala, Khajurwala, Sahurpur, NOCA
19. *Tringa totanus totanus* (Linnaeus) **Common Redshank** (393)	—	Occ	Asola (waterhole)
20. *Tringa ochropus* Linnaeus **Green Sandpiper** (397)	M	Occ	Sahurpur
21. *Tringa hypoleucos* Linnaeus **Common Sandpiper** (401)	M	UnCom	BMA, Sahurpur

	Status in Delhi	Abundance in AB-WLS	Localities within Asola-Bhatti WLS
8. Family RECURVIROSTRIDAE			
22. *Himantopus himantopus himantopus* (Linnaeus) **Indian Blackwinged Stilt** (430)	R/M	Com	BMA, Pipalwala, Khajurwala, Sahurpur
VIII. Order COLUMBIFORMES			
9. Family PTEROCLIDIDAE			
23. *Pterocles indicus indicus* (Gmelin) **Painted Sandgrouse** (492)	—	Occ	Asola (waterhole)
10. Family COLUMBIDAE			
24. *Columba livia intermedia* Strikland **Blue Rock Pigeon** (517)	R	Com	BMA, Pipalwala, Khajurwala, Sahurpur, Maidangarhi, Deoli, NOCA
25. *Streptopelia decaocto decaocto* (Frivaldszky) **Indian Ring Dove** (534)	R	Occ	NOCA
26. *Streptopelia chinensis suratensis* (Gmelin) **Indian Spotted Dove** (537)	M	UnCom	Khajurwala, Sahurpur, NOCA
27. *Streptopelia senegalensis cambayensis* (Gmelin) **Indian Little Brown** or **Senegal Dove** (541)	R	Com	BMA, Pipalwala, Khajurwala, Deoli, NOCA
IX. Order **Psittaciformes**			
11. Family Psittacidae			
28. *Psittacula krameri manillensis* (Bechstein) **Roseringed Parakeet** (550)	R	Com	BMA, Pipalwala, Khajuriwala, Sahurpur, Deoli, NOCA
29. *Psittacula cyanocephala bengalensis* (Forster) **Northern Blossomheaded Parakeet** (557)	R	Occ	Pipalwala

	Status in Delhi	Abundance in AB-WLS	Localities within Asola-Bhatti WLS
X. Order CUCULIFORMES			
12. Family CUCULIDAE			
30. *Clamator jacobinus serratus* (Sparrman) **Pied Crested Cuckoo** (570)	M	Occ	Deoli
31. *Cuculus varius varius* Vahl **Common Hawk-Cuckoo/ Brainfever Bird** (573)	M	UnCom	Sahurpur, Maidangarhi
32. *Taccocua leschenaultii sirkee* (J. E. Gray) **Western Sirkeer Cuckoo** (596)	R	UnCom	Sahurpur, Maidangarhi
XI. Order STRIGIFORMES			
13. Family STRIGIDAE			
33. *Athene brama indica* (Franklin) **Northern Spotted Owlet** (650)	R	Com	BMA, Pipalwala, Khajurwala, NOCA
XI. Order APODIFORMES			
14. Family APODIDAE			
34. *Apus affinis affinis* (J. E. Gray) **Indian House Swift** (703)	R	Com	BMA, Pipalwala, Khajurwala, NOCA
XIII. Order CORACIIFORMES			
15. Family ALCEDINIDAE			
35. *Ceryle rudis leucomelanura* Reichenbach **Indian Pied Kingfisher** (719)	R	Occ	BMA
36. *Halcyon smyrnensis smyrnensis* (Linnaeus) **Whitebreasted Kingfisher** (735)	R	UnCom	BMA, Sahurpur
16. Family MEROPIDAE			
37. *Merops orientalis orientalis* Latham **Indian Small Green Bee-eater** (750)	R	UnCom	Sahurpur, Deoli

	Status in Delhi	Abundance in AB-WLS	Localities within Asola-Bhatti WLS
17. Family CORACIIDAE			
38. *Coracias benghalensis benghalensis* (Linnaeus) **Northern Roller** or **Blue Jay** (755)	R	UnCom	BMA, Pipalwala
18. Family UPUPIDAE			
39. *Upupa epops epops* Linnaeus **European Hoopoe** (763)	R/M	Com	BMA, Pipalwala, Khajurwala, Maidangarhi, Deoli, NOCA
19. Family BUCEROTIDAE			
40. *Tockus birostris* (Scopoli) **Grey Hornbill** (767)	R/M	Occ	Pipalwala
XIV. Order PICIFORMES			
20. Family Picidae			
41. *Dinipium bengalense bengalense* (Linnaeus) **Northern Goldenbacked Woodpecker** (819)	R/M	UnCom	Sahurpur, Maidangarhi
XV. Order PASSERIFORMES			
21. Family HIRUNDINIDAE			
42. *Riparia paludica chinensis* (J. E. Gray) **Indian Greythroated Sand Martin** (912)	R	UnCom	BMA, BOCA
43. *Hirundo concolor concolor* Sykes **Dusky Crag Martin** (914)	—	Occ	BMA (Bhatti, near mine and scrubs)
44. *Hirundo rustica rustica* Linnaeus **Western Swallow** (915)	M	UnCom	Sahurpur, Deoli, NOCA
45. *Hirundo smithii filifera* Stephens **Indian Wiretailed Swallow** (921)	R	Occ	Deoli
22. Family LANIIDAE			
46. *Lanius schach erythronotus* (Vigors) **Rufousbacked Shrike** (946)	R/M	UnCom	Sahurpur, NOCA

	Status in Delhi	Abundance in AB-WLS	Localities within Asola-Bhatti WLS
23. Family ORIOLIDAE			
47. *Oriolius oriolius kundoo* Sykes **Indian Golden Oriole** (953)	M	UnCom	Deoli, NOCA
24. Family DICRURIDAE			
48. *Dicrurus adsimilis albirictus* (Hodgson) **North Indian Black Drongo** or **King Crow** (962)	R	Com	BMA, Pipalwala, Khajurwala, Deoli, NOCA
25. Family STURNIDAE			
49. *Sturnus pagodarum* (Gmelin) **Blackheaded** or **Brahminy Myna** (994)	R	UnCom	Maidangarhi, Deoli
50. *Sturnus roseus* (Linnaeus) **Rosy Starling** or **Rosy Pastor** (996)	M	Occ	Deoli
51. *Sturnus contra contra* Linnaeus **Indian Pied Myna** (1002)	R	UnCom	BMA, Sahurpur, Maidangarhi
52. *Acridotheres tristis tristis* (Linnaeus) **Indian Myna** (1006)	R	UnCom	Deoli, NOCA
53. *Acridotheres ginginianus* (Latham) **Bank Myna** (1008)	R	UnCom	BMA, Pipalwala, Khajurwala
26. Family CORVIDAE			
54. *Dendrocitta vagabunda* (Latham) **Treepie** (430/31)	R	Com	BMA, Pipalwala, Khajurwala, Maidangarhi, Deoli, NOCA
55. *Crovus splendens splendens* Vieillot **Indian House Crow** (1049)	R	Com	Pipalwala, Khajurwala, Sahurpur, Maidangarhi, Deoli, NOCA
56. *Corvus macrohynchos culminatus* Sykes **Indian Jungle Crow** (1057)	R	UnCom	BMA, NOCA
27. Family PYCNONOTIDAE			
57. *Pycnonotus leucogenys leucotis* (Gould) **White-eared Bulbul** (1123)	R	UnCom	Sahurpur, Maidangarhi, NOCA
58. *Pycnonotus cafer humayuni* Deignan **Central Indian Redvented Bulbul** (1127)	R	Com	BMA, Pipalwala, Khajurwala, Sahurpur, Maidangarhi, Deoli, NOCA

	Status in Delhi	Abundance in AB-WLS	Localities within Asola-Bhatti WLS
28. Family MUSCICAPIDAE			
59. *Chrysomma sinense sinense* (Gmelin) **Yellow-eyed Babbler** (1231)	R	Occ	Sahurpur
60. *Turdoides caudatus caudatus* (Dumont) **Common Babbler** (1254)	R	Occ	NOCA
61. *Turdoides malcolmi* (Sykes) **Large Grey Babbler** (1258)	R	Com	BMA, Pipalwala, Khajurwala, Deoli, NOCA
62. *Turdoides striatus sindianus* (Ticehurt) **Sind Jungle Babbler** (1261)	R	UnCom	BMA, Deoli
63. *Rhipidura aureda aureola* Lesson **Northern Whitebrowed Fantail Flycatcher** (1451)	R	UnCom	BMA, Pipalwala, Khajurwala
64. *Prinia subflava terricolor* (Hume) **Northwestern Plain Wren-Warbler** (1510)	R	UnCom	BMA, NOCA
65. *Prinia socialis stewarti* Blyth **Northern Ashy Wren-Warbler** (1515)	R	UnCom	Sahurpur, Deoli, NOCA
66. *Orthtomus sutorius guzuratus* (Latham) **Indian Tailor Bird** (1535)	R	Occ	Maidangarhi
67. *Phylloscopus collybita tristis* Blyth **Brown Chiffchaff** (1575)	M	Occ	NOCA
68. *Phylloscopus affinis affinis* (Tickell) **Tickell's Leaf Warbler** (1579)	M	UnCom	Sahurpur, NOCA
69. *Erithacus svecicus* Linnaeus **Bluethroat** (1644/45)	M	Occ	Sahurpur
70. *Copsychus saularis saularis* (Linnaeus) **Indian Magpie-Robin** (1661)	R	Com	Pipalwala, Khajurwala, Sahurpur, NOCA
71. *Phoenicurus ochruros phoenicuroides* (Moore) **Kashmir Black Redstart** (1671)	M	UnCom	BMA, Deoli
72. *Saxicola Caprata* (Linnaeus) **Pied Bush Chat** (1700)	R/M	UnCom	BMA, Deoli

	Status in Delhi	Abundance in AB-WLS	Localities within Asola-Bhatti WLS
73. *Saxicoloides fulicata cambaiensis* (Latham) **Brownbacked Indian Robin** (1717)	R	Com	BMA, Pipalwala, Khajurwala, Sahurpur, Maidangarhi, Deoli, NOCA
29. Family MOTACILLIDE			
74. *Anthus similis jerdon* Brown Rock **Pipit** (1866/67)	M	Occ	NOCA
75. *Motacilla caspica caspica* (Gmelin) **Grey Wagtail** (1884)	M	UnCom	BMA, Pipalwala,
76. *Motacilla alba* Linnaeus **White Wagtail** (1885)	M	Com	BMA, Pipalwala, Khajurwala, Sahurpur, Deoli, NOCA
30. Family NECTARINIIDAE			
77. *Nectarinia asiatica asiatica* (Latham) **Indian Purple Sunbrid** (1917)	R	UnCom	BMA, Pipalwala, NOCA
31. Family ZOSTEROPIDAE			
78. *Zosterops palpebrosa palpebrosa* (Temminck) **Indian White-eye** (1933)	R	UnCom	BMA, Pipalwala
32. Family PLOCEIDAE			
79. *Passer domesticus indicus* Jardline & Selby **Indian House Sparrow** (1938)	R	Com	Pipalwala, Khajurwala, Deoli, NOCA
80. *Ploceus philippinus philippinus* (Linnaeus) **Indian Baya** (1957)	R	UnCom	BMA, Deoli
81. *Estrilda amandava amandava* (Linnaeus) **Red Munia** or **Avadavat** (1964)	R	UnCom	BMA, NOCA
82. *Lonchura malabarica malabarica* (Linnaeus) **Whitethroated Munia** (1967)	R	Occ	NOCA

Note : **BMA** : Bhatti Mines Area covering Pit Nos. 2/3, 8, 9, 10, 11 and 12. **NOCA** : New Office Complex Area in Northern part of Asola Sanctuary covering about 2 km stretch inside the boundary wall. **R** : Resident, **M** : Migrant, **R/M** : Resident/Migrant, -: Information on status lacking.

ANNEXURE - VIII

LIST OF REPTILES FOUND IN WLS

Fauna of Conservation Area No. **16**, *Some Selected Fauna of Asola-Bhatti Wildlife Sanctuary* : 47-50, 2003

REPTILIA

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INTRODUCTION

The reptilian fauna of Delhi has not been throughly worked out during the past except for the basic work of Smith (1943) and some general references like in, Gazetteers of Delhi (Anonymous 1888; 1913; Raza *et. al.*, 1976), Census reports (Raj & Sehgal, 1964); Delhi Ridge Forest. (Kalpavriksh, 1991), Srishti Reports (Malik *et. al.*, 1996, Gaur, 1995), Newsl. IZDA/CZA Report (Anonymous, 1996), Recently Husain (1997) listed 25 species of reptiles belonging to orders Crocodyilia, Testudins, Sauria and Serpentes, adding three species, all belonging to Saurian, to the known reptilian fauna of Delhi and Gill (1997) described a new gekkonid, Cyrtodactylus aravallensis from the Delhi Ridge area.

During the present study four species of lizards and one snake could be recorded from the sanctuary area of which two are a new find for Delhi and four the first records for the sanctuary itself.

SYSTEMATIC ACCOUNT

I. Family AGAMIDAE

1. ***Calotes versicolar*** Daudin
Garden Lizard

Material Examined : Asola-Bhatti Wildlife Sanctuary, Sahurpur, 1 ex. (63+160 mm), 5.iii.1998, *Coll. S. K. Gupta*; Bhatti Mines, Pit No. 10/11, 1 ex. (75+238 mm), 26.x.1998, *Coll. Vinod Khanna*; Pipalwala; 1 ex. (66+130 mm), 18.xii.1999; Pit No. 9, 2 exs. (44+120, 51+135 mm), 19.xii.1999, *Coll. J. P. Sati & party.*

Distribution : India : Delhi and generally throughout. *Elsewhere* : Afghanistan, Pakistan, Sri Lanka, Malaysia, Hong King, Indonesia and China. First record from the Sanctuary.

Remarks : Arboreal, occurring in gardens, bushy and shrubby areas. Basically insectivore

also feeds on small birds, nesting, frogs, rodents, vegetative matter like leaves, seeds, flowers, etc. Breeds during summer and rainy season laying upto 25 eggs in different sized clutches in a hole dug by females in soft lower bed.

II. Family GEKKONIDAE

2. *Hemidactylus brooki* (Gray)
Spotted Brook's Gecko

Material Examined : Asola-Bhatti Wildlife Sanctuary, 1 ex., 12.ii.1995; *Coll. J. P. Sati & party*; Southern part, 1 ex. (30, tail broken); 5.viii.1997, *Coll. N. K. Sinha & party*; Pipalwala, ca 2 km from Asola FRH, 2 exs. (31+43, 36+46 mm), 28.ii.1998; Deoli area, 1 ex. (33+38 mm), 3.iii.1998; Dudhawali Khan in Bhatti Mines, 1 ex. (34+36 mm), 6.iii.1998, *Coll. S. K. Gupta & party*; Deoli, 1 ex. (42+52 mm), 28.x.1998; Imliwala, 1 ex. (37+44), 30.x.1998, *Coll. Vinod Khanna & party*; Pipalwala, 2 exs. (37+37, 47+55 mm), 18.xii.1999; Pit No. 9; 2 exs. (29+35, 47+48 mm), 19.xii.1999; Tughlakabad, towards Shooting range; 1 ex. (42+55 mm), *Coll. J. P. Sati & party*.

Distribution : India : Delhi and generally throughout. *Elsewhere* : Pakistan, Sri Lanka, Malaysia, Indonesia, China, Singapore, Africa (northern half) and West Indies. Earlier recorded both from the sanctuary and Delhi (Husain, 1997).

Remarks : Generally seen around pile of stones, bark of dead tree trunks, in crevices, old deserted buildings etc. Basically insectivorous, also feeds on small land molluscs, seeds of wild bushes etc. Breeds during summer period, female lays two small eggs in clutch, which hatch out in about 40 days time.

III. Family LACERTIDAE

3. *Ophisops jeidoni* (Blyth)
Snake-Eyed Lacerta

Material Examined : Asola-Bhatti Wildlife Sanctuary, Dudhawali Khan in Bhatti Mines, 1 ex. (20+24 mm), 6.iii.1998, *Coll. S. K. Gupta & party*; Tughlakabad, towards Shooting range; 1 ex. (21+48 mm), 24.xii.1999, *Coll. J. P. Sati & party*.

Distribution : India : Generally throughout. *Elsewhere* : Pakistan. First record from the sanctuary and also Delhi State.

Remarks : Burrowing, Diurnal, Insectivorous.

IV. Family SCINCIDAE

5. ***Riopa punctata*** Gray
Striped Kink

Material Examined : Asola-Bhatti Wildlife Sanctuary, ca 3 km south of Asola Administrative Block; 2 exs. (20, 42 mm + tail broken/regenerated), 2.iii.1998; Deoli area, 1 ex. (38-43 mm + tail), 3.iii.1998; Sahurpur, Asola, 2 exs. (45+58, 50+69 mm), 5.iii.1998, Dudhawali Khan in Bhatti Mines, 1 ex. (44 mm + tail), *Coll. S. K. Gupta & party*; Imliwala, 1 ex. (47 + tail), 30.x.1998, Coll. Dudhawali Khan in Bhatti Mines, 1 ex. (20 + 24 mm), 6.iii.1998, *Coll. S. K. Gupta & party*.

Distribution : India : Delhi and widely distributed both in plains and hilly terrain. *Elsewhere* : Sri Lanka, Vietnam. First record from the sanctuary area.

Remarks : Prefers moist soil, underneath stones, old bricks or old logs. Insectivorous. Female covers the eggs by soil after laying.

Order SERPENTES
V. Family TYPHLOPIDAE

6. ***Typhlops porrectus*** Stoliczka
Slender Work Snake

Material Examined : Asola-Bhatti Wildlife Sanctuary, Sahurpur 1 ex. (80 mm), 22.xii.1999, *Coll. J. P. Sati & party*.

Distribution : India : Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Bihar, West Bengal, Orissa, Maharashtra, Karnataka and Kerala. Elsewhere : Pakistan, Sri Lanka and Myanmar. First record from the Sanctuary and also Delhi.

Remarks : Inhabits burrowing in upper lose soil, around roots of bushes and decayed wooden logs. Nocturnal. Insectivorous. Female lays tiny, elongated, white eggs during summer and rainy seasons. Non-venomous.

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ANNEXURE - IX

LIST OF AMPHIBIANS FOUND IN WLS

Fauna of Conservation Area No. **16**, *Some Selected Fauna of Asola-Bhatti Wildlife Sanctuary* : 43-45, 2003

AMPHIBIA

AKHLAQ HUSAIN

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INTRODUCTION

The Amphibian Fauna of Delhi received only a little attention of herpetologists during the past except for some general references (Raj & Seghal, 1964; Raza *et. al.*, 1976; Kalpavriksh, 1991; Malik *et. al.*, 1994) and the recent faunistic survey report on the subject by Husain (1997).

During the present study five species belonging to three genera were collected from the sanctuary area, of which four species are being recorded for first time.

SYSTEMATIC ACCOUNT

Order ANURA

I. Family BUFONIDAE

1. ***Bufo melanostictus*** Schneider

Common Toad

Material Examined : Asola-Bhatti Wildlife Sanctuary, Northern part, 1 ex. (17 mm), 9.viii.1997, *Coll. N. K. Sinha & party*; Bhatti Mines area, ca 2 km from Asola FRH, 2 exs. (34, 56 mm), 1.iii.1998; Dudhawali Khan in Bhatti Mines, 1 ex. (34 mm), 6.iii.1998, *Coll. S. K. Gupta & party*.

Distribution : India : Delhi and generally throughout. *Elsewhere* : Pakistan, Nepal, Bangladesh, Sri Lanka, Myanmar, Malayasia, China, Hong Kong, Indonesia, Philippines. First record from the Sanctuary area.

Remarks : Inhabit under stones, wooden logs and near water bodies during the breeding season. Nocturnal. Insectivore.

2. ***Bufo stomaticus*** Lutken

Marbled Toad

Material Examined : Asola-Bhatti Wildlife Sanctuary, Central part, 2 exs., (23, 24 mm), 8.viii.1997, *Coll. N. K. Sinha & party.*

Distribution : India : Delhi, Punjab, Uttar Pradesh, West Bengal, Assam, Maharashtra. *Elsewhere* : Oman, Pakistan, Nepal, Bangladesh, Sri Lanka and Myanmar. First record from the Sanctuary area.

Remarks : Terrestrial, found near water bodies during the breeding season only. Nocturnal and Insectivore. Husain (1997) reported in the month of February, May and September from Delhi.

II. Family MICROHYLIDAE

3. ***Microhyla ornata*** (Dumeril & Bibron)

Ornate Frog

Material Examined : Asola-Bhatti Wildlife Sanctuary, central part, 3 exs. (10-12 mm), 7.iii.1997; 1 ex. (13 mm), 8.iii.1997, *Coll. N. K. Sinha & party*; Dudhawali Khan in Bhatti Mines, 1 ex. (13 mm), 6.iii.1998, *Coll. S. K. Gupta & party*; Sahurpur, 1 ex. (17 mm), 22.xii.1999, *Coll. J. P. Sati & party.*

Distribution : India : Delhi and generally throughout. *Elsewhere* : Pakistan, Nepal, Bangladesh, Sri Lanka, Myanmar, China, Taiwan and Southeast Asia.

Remarks : Generally seen around bushy areas, dry leaves on moist soil, banks of water bodies. Nocturnal, sometimes also seen during the daytime. Insectivore : Juveniles have been in the month of February in Delhi (Husain, 1997).

III. Family RANIDAE

4. ***Rana cyanophlyctis*** Schneider

Skipping Frog

Material Examined : Asola-Bhatti Wildlife Sanctuary, 1 ex. (58 mm), 12.ix.1994, *Coll. J. P. Sati & party*; southern side of sanctuary, 13 exs. (22-33 mm), 4.viii.1997, *Coll. N. K. Sinha & party.*

Distribution : India : Delhi and generally throughout. *Elsewhere* : Iran, Saudi Arabia,

Afghanistan, Pakistan, Nepal, Bangaladesh, Sri Lanka, Thailand and Malaysia. Earlier recorded from the sanctuary area.

Remarks : Generally found in ponds, ditches and nalas and may tolerate extremely polluted waters. Insectivore. As regards breeding habits, its tadpoles have been reported during the months of February, May, June and December in Delhi (Husain, 1997).

5. ***Rana limnocharis*** Boie, Cricket Frog

Material Examined : Asola-Bhatti Wildlife, Sanctuary, Central part, 1 ex. (16 mm), 8.viii.1997, *Coll. N. K. Sinha & party*; Dudhawala Khan in Bhatti Mines, 1 ex. (13 mm), 6.iii.1998, *Coll. S. K. Gupta & party*; Pit No. 9, 1 ex. (41 mm), 19.xii.1999, *Coll. J. P. Sati & party*.

Distribution : India : Delhi and generally throughout (including Andaman and Nicobar Islands). Elsewhere : Pakistan, Nepal, Bangladesh, Myanmar, Thailand, Mlaysia, Hong Kong, China, Indonesia, Taiwan, Philippines and Japan. First record from the Sanctuary.

Remarks : Commonly occurs in water edges or under stones near water bodies. Insectivore. Their juveniles have been reported in the month of February (Husain, 1997).

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ANNEXURE- XX

LIST OF BUTTERFLIES AND MOTHS FOUND IN WLS

Fauna of Conservation Area No. 16, Some Selected Fauna of Asola-Bhatti Wildlife Sanctuary : 31-38, 2003

LEPIDOPTERA : RHOPALOCERA

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INTRODUCTION

Mondal, *et. al.* (1997) recorded 19 species, while Gupta (1997) recorded nine species of Lepidoptera (Rhopalocera) from Delhi. These included four species from the area falling under Asola-Bhatti Wildlife Sanctuary. Kumar, *et. al.* (1997) provided a list of 90 species belonging to five families i.e., Pieridae, Danaidae, Nymphalidae, Lycaenidae and Satyridae, based on the study of the material collected by the scientists of Northern Regional Station, Zoological Survey of India, Dehra Dun from Delhi, including Asola-Bhatti Wildlife Sanctuary.

SYSTEMATIC ACCOUNT

The systematic accounts deals with 25 species of butterflies under 5 families.

Family PIERIDAE

1. ***Anaphaeis aurota*** (Fabricius)
The Pioneer

Material Examined : Asola-Bhatti Wildlife Sanctuary, Shooting range, Tughlakabad, 1 ex., 2.viii.1997; near Sahurpur, 1 ex., 7.viii.1997, *Coll. N. K. Sinha & party*; Asola, FRH, ca 2 km towards Khajurwala, 1 ex., 27.ii.1998, *Coll. S. K. Gupta & party*; Deoli, 2 exs., 21.xii.1999, *Coll. J. P. Sati & party.*

Distribution : India : Delhi, rest of the mainland except Assam, Andaman & Nicobar Islands. *Elsewhere* : Sri Lanka : Extending to Middle East and Africa.

2. ***Cepora nerissa phryne*** (Fabricius)
The Common Gull

Material Examined : Asola-Bhatti Wildlife Sanctuary, Shooting range, Tughlakabad, 2 exs., 27.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Throughout peninsular India, Delhi, Jodhpur in Rajasthan. *Elsewhere* : Pakistan.

3. ***Ixias marianne*** (Cramer)

The White Orange Tip

Material Examined : Asola-Bhatti Wildlife Sanctuary, near Pit No. 2, Southern Part, 1 ex., 4.viii.1997, near Sahurpur, 2 exs., 7.viii.1997, *Coll. N. K. Sinha & party*; Khajurwala, 1 ex., 24.x.1996; Pipalwala, 1 ex., 25.x.1998; Shooting range, Tughlakabad, 3 exs., 27.x.1996; Deoli, 3 exs., 28.x.1998; Maidangarhi, 1 ex., 29.x.1996; Satbari, 1 ex., 29.x.1996; Imliwala, 2 exs., 30.x.1998, *Coll. Vinod Khanna & party*.

Distribution : India : Delhi, Throughout Peninsular; West and N. W. Himalaya. *Elsewhere* : Sri Lanka, Pakistan and Nepal.

4. ***Ixias pyrene*** (Linnaeus)

The Yellow Orange Tip

Material Examined : Asola-Bhatti Wildlife Sanctuary, Shooting range, Tughlakabad, 1 ex., 2.viii.1997; near Sahurpur, 1 ex., 7.viii.1997, *Coll. N. K. Sinha & party*.

Distribution : India : Delhi, Peninsular India to Saurashtra and Bengal, N. W. Himalaya to Assam. *Elsewhere* : Pakistan, Sri Lanka, Myanmar and Nepal.

5. ***Eurema brigitta*** Stoll

Small Grass Yellow

Material Examined : Asola-Bhatti Wildlife Sanctuary, near Sahurpur, 1 ex., 7.viii.1997, *Coll. N. K. Sinha & party*; Sahurpur, 2 exs., 5.iii.1998, *Coll. S. K. Gupta & party*; Bhatti Mines, Pit No. 2, 2 exs., 19.xii.1999, *Coll. J. P. Sati & party*.

Distribution : India Throughout. *Elsewhere* : Sri Lanka, Myanmar and Nepal.

6. ***Eurema hecabe*** (Linnaeus)

The Common Grass Yellow

Material Examined : Asola-Bhatti Wildlife Sanctuary, Shooting range, Tughlakabad, 1 ex., 2.viii.1997; near Pit No. 2, 1 ex., 4.vii.1997, *Coll. N. K. Sinha & party*; Khajurwala, 3 exs., 24.x.1998; Bhatti Mines, Pit no. 10-11, 2 exs., 26.x.1998; Satbari, 2 exs., 29.x.1998; Imliwala, 1 ex., 30.x.1998, *Coll. Vinod Khanna & party*.

Distribution : India : Delhi. Throughout rest of mainland, Andaman & Nicobar Islands; Lakshadeep. Elsewhere : Throughout Ethiopian and Indo-Australian region; North wards to Korea and Japan.

7. ***Eurema laeta*** Boisduval
The Spotless Yellow

Material Examined : Asola-Bhatti Willife Sanctuar, near Sahurpur, 1 ex., 7.viii.1997, *Coll. N. K. Sinha & party*; Maidangarhi, 1 ex., 29.x.1998; Imliwala, 1 ex., 30.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Delhi. Throughout plains and the hills of the main land. *Elsewhere* : Sri Lanka, Myanmar, North to China; Japan and Amur; also south to Hainan, Vietnam, Java, Philippines and Timor to Kei Islands.

8. ***Catopsilia pomona*** (Fabricius)
The Lemon Emigrant

Material Examined : Asola-Bhatti Wildlife Sanctuary, Shooting range, Tughlakabad, 1 ex., 27.xii.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Delhi, rest of the main land, Andaman & Nicobar Islands. *Elsewhere* : Myanmar, Pakistan, Sri Lanka, South China to Australia and the Pacific.

9. ***Catopsilia pyranthe*** (Linnaeus)
The Mottled Emigrant

Material Examined : Asola-Bhatti Wildlife Sanctuary, near Sahurpur, 2 exs., 7.viii.1997; near Administrative block, DCF's Office, 1 ex., 9.viii.1997, *Coll. N. K. Sinha & party*; Khajurwala, 1 ex., 27.ii.1998, *Coll. S. K. Gupta & party.*

Distribution : India : Common throughout India. *Elsewhere* : Pakistan.

10. ***Catopsilia florella*** (Fabricius)
The African Emigrant

Material Examined : Asola-Bhatti Wildlife Sanctuary, Shooting range, Tughlakabad, 1 ex., M, 4.viii.1997, *Coll. N. K. Sinha & party*; Bhatti Mines, Pit No.10-11, 1 ex., 26.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Delhi, rest of the mainland; Andaman & Nicobar Island. *Elsewhere* : Pakistan, Sri Lanka, Myanmar to Indo-China, Hainan to South China, Africa to Arabia and Iran.

11. ***Colotis etrida*** (Boisduval)

The Little Orange Tip

Material Examined : Asola-Bhatti Wildlife Sanctuary, Deoli, 1 ex., 21.xii.1999, *Coll. J. P. Sati & party.*

Distribution : India : Delhi and throughout mainland. *Elsewhere* : Pakistan and Sri Lanka.

12. ***Colotis fausta*** (Olivier)

The Large Salmon Arab

Material Examined : Asola-Bhatti Wildlife Sancturay, Shooting range, Tughlakabad, 1 ex., 24.xii.1999, *Coll. J. P. Sati & party.*

Distribution : India : Delhi. Throughout peninsular India. *Elsewhere* : Palestine to Arabia, Turkistan, Egypt, Somaliland, Iran, Afghanistan, Pakistan and Sri Lanka.

13. ***Appias libythea*** (Fabricius)

The Striped Albatross

Material Examined : Asola-Bhatti Wildlife Sanctuary, near Administrative Block, ca 3 km south of Asola, 1 ex., 2.iii.1998, *Coll. S. K. Gupta & party*; Deoli, 1 ex., 28.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Delhi, Rajasthan, Punjab and Peninsular India. *Elsewhere* : Pakistan.

Family DANAIDAE

14. ***Danaus chrysippus*** (Linnaeus)

The Plain Tiger

Material Examined : Asola-Bhatti Wildlife Sanctuary, near Sahurpur, 2 exs., 7.viii.1997, *Coll. N. K. Sinha & party*; near Administrative Block, Tughlakabad, 1 ex., 2.iii.1998; Deoli, 4 exs., 3.iii.1998, *Coll. S. K. Gupta & party*; Bhatti Mines, 1 ex., 26.x.1998; Shooting range, Tughlakabad, 1 ex., 27.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Delhi, throughout the mainland. *Elsewhere* : Widespread in the Oriental, Palaearctic, Ethiopian and Australian regions.

Family NYMPHALIDAE

15. *Cynthia cardui* (Linnaeus)

The Painted Lady

Material Examined : Asola-Bhatti Wildlife Sanctuary, Imliwala, 1 ex., 30.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Throughout. *Elsewhere* : Sri Lanka, Myanmar, widely distributed except South America.

16. ***Hypolimnas bolina*** (Linnaeus)

The Great Eggfly

Material Examined : Asola-Bhatti Wildlife Sanctuary, Bhatti Mines, 1 ex., 26.x.1998; Maidangarhi, 1 ex., 29.x.1998; Bhatti Mines, 2 exs., 30.x.1998; Imliwala, 1 ex., 30.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Throughout. *Elsewhere* : Myanmar, Sri Lanka, Pakistan.

17. ***Phalanta phalanta phalanta*** (Drury)

The Common Leopard

Material Examined : Asola-Bhatti Wildlife Sanctuary, near Pit No. 2, 1 ex., 4.viii.1997; near Administrative Block, ca 3 km S. W. DCF's Office, 1 ex., 9.viii.1997, *Coll. N. K. Sinha & party*; Shooting range, Tughlakabad, 1 ex., 27.x.1998; Deoli, 1 ex., 28.x.1998; Maidangarhi, 1 ex., 29.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Throughout India including Nicobar Islands. *Elsewhere* : Sri Lanka, Myanmar and Pakistan.

18. ***Precis almana almana*** (Linnaeus)

The Peacock Pansy

Material Examined : Asola-Bhatti Wildlife Sanctuary, Shooting range, Tughlakabad, 1 ex., 27.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India : Throughout India except Andaman & Nicobar Islands. *Elsewhere* : Sri Lanka and Myanmar.

19. ***Precis hierta*** Fabricius

The Yellow Pansy

Material Examined : Asola-Bhatti Wildlife Sanctuary, near Pit No. 2, 1 ex., 4.viii.1997; near Sahurpur, 1 ex., 7.vii.1997; near DCF's Office, 1 ex., 9.viii.1997, *Coll. N. K. Sinha & party*; Shooting range, Tughlakabad, 1 ex., 27.x.1998; Satbari, 2 exs., 29.x.1998; Imliwala, 1 ex., 31.x.1998, *Coll. Vinod Khanna & party*.

Distribution : India : Throughout. *Elsewhere* : Sri Lanka and Myanmar.

20. ***Precis orithyia swinhoei*** (Butler)

Blue Pansy

Material Examined : Asola-Bhatti Wildlife Sanctuary, Pipalwala, ca 2 km from Asola FRH, 1 ex., 28.ii.1998; Bhatti Mines, ca 2 km Asola FRH, 3 exs., 1.iii.1998, *Coll. S. K. Gupta & party*; Pipalwala, 1 ex., 25.x.1998; Deoli, 1 ex., 28.x.1998; Maidangarhi, 1 ex., 29.x.1998; Satbari, 2 exs., 29.x.1998; Imliwala, 2 exs., 30.x.1998, *Coll. Vinod Khanna & party*.

Distribution : India : Delhi, Kashmir to Kumaon, Assam, West Bengal, Rajasthan, South India. *Elsewhere* : Myanmar, Sri Lanka and Pakistan.

21. ***Precis lemonias lemonias*** (Linnaeus)

The Lemon Pansy

Material Examined : India : Delhi, Asola-Bhatti Wildlife Sanctuary, near Sahurpur, 1 ex., 7.viii.1997, *Coll. N. K. Sinha & party*; Shooting range, Tughlakabad, 1 ex., 27.01.1998, Deoli, 1 ex., 28.10.1998, *Coll. Vinod Khanna & party*.

Distribution : India : Delhi, Kashmir to Kumaon, Assam, West Bengal, Rajasthan, South India. *Elsewhere* : Myanmar, Sri Lanka and Pakistan.

Family LYCAENIDAE

22. ***Zizeeria otis*** (Murray)

The Lesser Grass Butterfly

Material Examined : Asola-Bhatti Wildlife Sanctuary, Imliwala, 1 ex., 28.02.1998; Bhatti

Mines areas, 1 ex., 1.ii.1998, *Coll. S. K. Gupta & party*; Imliwala, 1 ex., 30.x.1998, *Coll. Vinod Khanna & party*.

Distribution : India : Throughout. *Elsewhere* : Sri Lanka, Myanmar and Nepal.

23. *Zizeeria maha maha* (Kollar)

The Pale Grass Blue

Material Examined : Asola-Bhatti Wildlife Sanctuary, Bhatti Mines area, 2 exs., 1.iii.1998, *Coll. S. K. Gupta & party*.

Distribution : India : Throughout. *Elsewhere* : Myanmar, Pakistan (Baluchistan).

Family SATYRIDAE

24. *Ypthima incia* Hewitson

The Lesser Three Ring

Material Examined : Asola-Bhatti Wildlife Sanctuary, Shooting range, Tughlakabad, 1 ex., 02.ii.1998, *Coll. S. K. Gupta & party*.

Distribution : India : Delhi, Punjab to West Bengal, Madhya Pradesh. *Elsewhere* : Pakistan.

25. *Melanitis leda ismene* (Cramer)

Common Evening Brown

Material Examined : Asola-Bhatti Wildlife Sanctuary, Maidangarhi, 1 ex., 29.x.1996, *Coll. Vinod Khanna & party*.

Distribution : India : Throughout. *Elsewhere* : Pakistan.

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ANNEXURE - XI

LIST OF FISHES FOUND IN WLS

Fauna of Conservation Area No. **16**, *Some Selected Fauna of Asola-Bhatti Wildlife Sanctuary* : 39-41, 2003

PISCES

AKHLAQ HUSAIN
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INTRODUCTION

The Fish fauna of Delhi has attracted the attention of various workers (Day, 1871, 1876, 1877, 1878, 1889; Majumdar, 1951, 1958; Jayram, 1981; during the past. Recently Husain (1997) explored the fish fauna of the NCT of Delhi thoroughly and added 16 species to the existing records making it 87 species and also observed that many species, earlier recorded, no more occur in the area due to various reasons affecting their habitats. The Asola-Bhatti Wildlife Sanctuary recently carved from Delhi State, bear some water pits in Bhatti mines area only and so the fish life is also scarce. During the present study only three species could be collected from the sanctuary area, of which one is new even to the Delhi.

SYSTEMATIC ACCOUNT

Class OSTEICHTHYES
Order CYPRINIFORMES
I. Family CYPRINIDAE

1. ***Puntius sophore*** (Hamilton-Buchanan)
Spot-Fin Carb

Material Examined : Asola-Bhatti Wildlife Sanctuary, Pipalwala, ca 2 km from Asola FRH, 82 exs., 28.ii.1998, *Coll. S. K. Gupta & party*; 37 exs. (18-50 mm), 25.x.1998, *Coll. Vinod Khanna & party.*

Distribution : Delhi, generally throughout the plains. *Elsewhere* : Pakitan, Nepal, Bangladesh, Myanmar, Sri Lanka and China. First record from the Sanctuary.

Remarks : Inhabits ponds, pools and moving nalas, Omnivorous, feeding both on vegetable

matter and insects. Breeds during monsoon months. Well Known aquarium Fish. Useful in eradication of mosquito larvae.

Order PERCIFORMES

II. Family CHANNIDAE

2. ***Ophiocephalus gachua*** Hamilton-Buchanan

Brown Snakehead

Material Examined : Asola-Bhatti Wildlife Sanctuary, Pipalwala, 6 Exs. (39-78 mm), 25.x.1998, *Coll. Vinod Khanna & party.*

Distribution : India Delhi and throughout the plains and base of hills. *Elsewhere* : Afghanistan, Iran, Pakistan, Nepal, Bangladesh, China, Myanmar, Malaysia, Thailand, Sri Lanka and Borneo. First record from the Sanctuary.

Remarks : Inhabits low land water bodies and base of hills. Carnivore, feeding on insects, small fishes and frogs. Breeds during monsoon months. Helps in destroying mosquito larvae.

III. Family POECILIDAE

3. ***Gambusia affinis*** (Baind & Girar)

Mosquito Fish

Material Examined : Asola-Bhatti Wildlife Sanctuary, Pit No. 9, 1 ex. (46 mm), 19.xii.1999, *Coll. J. P. Sati & party.*

Distribution : India : Introduced throughout plains. *Elsewhere* : United States of America. Introduced into Pakistan, Nepal, Bangladesh, Sri Lanka, Thailand, Myanmar, Malaysia, Formosa, Hawaii, Italy and Philippines. First record from the Sanctuary and also Delhi.

Remarks : Hardy, small fish, withstanding all types foul water conditions and can tolerate both cold and warm waters equally. Voracious feeder, consuming mosquitoes and other insect larvae almost equal to its own weight per day and hence used in malaria eradication program.

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Palatable Plant Species Serving Food to Wildlife

The climate of sanctuary marked by periodicity and in is characterized by a dry and increasingly hot season from March – June, cold winter from October to February and a warm monsoon period from July – September. During three distinct vegetation seasons major palatable species are available in rainy season (July – September).

A total of 28 browse species were ranked 7 species were ranked as frequently consumed, 7 species as occasionally taken and 14 species as rarely consumed. Among the species taken frequently, *Carrisa opaca* and *Ziziyphus nummularia* were widely distributed in the sanctuary. *Carrisa* and *Ziziyphus* in-spite of being heavily browsed were locally abundant, but showed a stunted appearance Ziziphus is also the most important fodder species and as such is lopped heavily. Few scattered *Ziziyphuus* shrubs that escaped browsing were of 1-15 m height.

Ranked Palatable Plant Species for Goat

According to their frequency of consumption, plant species were ranked. 4 species i.e. *Canchrus ciliaris, Boerhavia diffusa, Aristida adscendensionis* and *Tephrosia villosa* were frequently taken. Seven species were consumed occasionally while species were rarely taken.

Among the species taken occasionally, *Ziziyphus nummularia, Maytenus senegalensis* and dry fallen leaves of *Anogeissus pendula* are important contributors. Leaves of *Grewia tenax* are also known to be highly palatable to cattle, but were rarely taken probably due to their being relatively less abundant when compared to other important browse species. The high livestock biomass and their ranging behaviour which affect the whole sanctuary was found to have an adverse impact on the physical structure of browse species. A reduction in the availability and quantity of dry grass biomass was also indicated due to repeated trampling.

True feral were not found in the sanctuary. Though cattle are set free into the sanctuary, once milk production stops, they are generally herded back by owners before calving season commences. Thus, the number of cattle within the sanctuary

fluctuates but cattle are always present within the sanctuary. It was reported that cattle camps are established along the sanctuary to graze. It was also reported that within Asola Bhatt WLS, domestic livestock number shoot up during this season.

Dietary Overlap

With reference to the palatable species of goat, 5 frequently consumed plants i.e. *Capparis sepiaria, Ziziyphus nummularia, Grewia tenax, Maytenus senegalensis* and *Securinega leucopyrus* are among the known browse species of nilgai, constituting a dietary overlap. Dietary overlap species between cattle and nilgai for browse were *Ziziyphus, Maytenus nad Anogeissus.*

Carrisa and *Ziziyphus* are the major diet species of nilgai which are being actively selected by domestic livestock. *Grewia tenax* which has a scattered distribution is also taken by nilgai. Dry and fallen leaves of *Anogeissus pendula* are actively taken by cattle and goats when available.

Among other important species, *Acacia leucophloea* (leaves), *Prosopis juliflora* (pods), *Ziziyphus oenoplia* (leaves and fruits), *Capparis sepiaria* (leaves) and *Capparis deciduas* constitute a dietary *overlap.* Important palatable species of nilgai are facing pressure from both domestic livestock and lopping.

Pressures on Palatable Species of Nilgai

Plant Species	Browse	Lopped
Capparis deciduas	*	-
Capparis sepiaria	*	-
Carrisa opeca	***	-
Ziziyphus oenoplia	**	-
Ziziyphus nummularia	***	***
Anogeissus pendula	**	**
Acacia leucophloea	*	*
Acacianilotica ssp.indica	*	-
Securinega leycopyrus	*	-

*low **medium ***high pressure

Annexure XIII

Dia. Class wise Assessment of Tree Population

Assessment of tree population has been carried out by laying out systematically distributed sample plots in the entire Asola Bhatti WLS area

Complete enumeration was done in the selected 119 sample plots. The statistical analysis of the collected data as accomplished by the statistician is given below:

Table 1: Species wise number of trees in different dia-classes in the sample plots

Species	Dia. Class in Cms.								Total No of Trees
	5--10	10--15	15-20	20-25	25-30	30-35	35-40	40-45	
Keekar	1346	803	175	48	20	8	4	2	2406
Ronj	143	203	118	39	7	5	1	0	516
Hingot	186	72	23	5	1	0	0	0	287
Pasendu	113	131	32	5	6	0	0	0	287
Dhak	37	43	27	11	4	9	0	0	131
Kakeda	70	35	4	0	0	0	0	0	109
Dhau	34	34	13	6	0	0	0	0	87
Kair	44	16	1	1	0	0	0	0	62
Neem	15	24	3	6	3	0	0	0	51
Heens	23	6	2	1	0	0	0	0	32
Karounda	26	4	0	0	0	0	0	0	30
Shisham	7	16	3	0	1	0	0	0	27
Peepal	1	5	2	0	4	7	0	0	19
Kareel	32	8	3	0	0	0	0	0	43
Chudail papdi	2	5	2	2	1	1	2	0	15
Jhot	0	5	1	3	2	0	0	0	11
Barna	0	3	3	4	0	0	0	0	10

Annexure XIII (a)

Table 2: Estimation of dia-class wise tree population along with Standard Error

Species	5-10 (SE %)	10-15 (SE %)	15-20 (SE%)	20-25 (SE%)	25-30 (SE%)	30-35 (SE%)	35-40 (SE%)	40-45 (SE%)
Prosopis juliflora (Kabuli Kikar)	124761 (11.6)	74430 (12.1)	16221 (16.7)	4449 (36.8)	1854 (51.3)	742 (65.5)	371 (71.9)	185 (83.3)
Acacia leucophloea (Raunj)	13255 (15.9)	18816 (14.7)	10937 (19.2)	3615 (30.8)	649 (49.8)	463 (61.9)	93 (118.4)	0
Carissa opaca (Karounda)	2410 (40.5)	371 (58.4)	0	0	0	0	0	0
Balanites aegyptiaca (Hingot)	17240 (30.4)	6674 (29.4)	2132 (41.5)	463 (61.9)	93 (118.4)	0	0	0
Holoptelia integrifolia (Chudail papdi)	185 (83.3)	463 (70.5)	185 (83.3)	185 (118.4)	93 (118.4)	93 (118.4)	185 (83.3)	0
Diospyros montana var. *cardiafolia* (Pasendu)	10474 (21.7)	12142 (17.8)	2966 (34.7)	463 (78.1)	556 (61.7)	0	0	0
Capparis sepiaria (Heens)	2132 (40.9)	556 (73.3)	185 (83.3)	93 (118.4)	0	0	0	0
Capparis decidua (Kareel)	2966 (57.7)	742 (80.6)	278 (118.3)	0	0	0	0	0
Acacia senegal (kairi)	4078 (42.7)	1483 (41.9)	93 (118.4)	93 (118.4)	0	0	0	0
Butea monosperma (Dhak)	3430 (46.9)	3986 (36.4)	2503 (49.2)	1020 (43.2)	371 (58.4)	834 (67.7)	0	0
Anogeissus pendula (Dhau)	3151 (50.9)	3151 (45.3)	1205 (46.2)	556 (73.3)	0	0	0	0
Dalbergia sissoo (Shisham)	649 (49.7)	1483 (46.9)	278 (118.4)	0	93 (118.4)	0	0	0
Azadirachta indica (Neem)	1390 (53.2)	2225 (40.6)	278 (67.7)	556 (61.7)	278 (87.9)	0	0	0
Maytenus senegelanses (Kakera)	6488 (30.9)	3244 (59.8)	371 (93.3)	0	0	0	0	0
Ficus religiosa (Peepal)	93 (118.4)	463 (61.9)	185 (83.3)	0	371 (83.3)	649 (69.2)	0	0
Crateva adansonii DC. ssp. *odora* (Barna)	0	278 (87.9)	278 (118.4)	371 (118.4)	0	0	0	0
Sesbania sesban (Jhot)	0	463 (52)	93 (118)	278 (88)	185 (118)	0	0	0

Table 3: Estimation of tree population of Protected Area

Botanical Name	Common Name	Estimated Trees (SE %)
Prosopis juliflora	Kabuli Kikar	221,154 (9.53)
Acacia leucophloea	Raunj	47,430 (12.62)
Diospyros montana var. *cardiafolia*	Pasendu	26,380 (16.78)
Balanites aegyptiaca	Hingot	26,380 (25.47)
Butea monosperma	Dhak	12,041 (34)
Maytenus senegelanses	Kakera	10,019 (36.37)
Anogeissus pendula	Dhau	7,997 (38.4)
Carissa opaca	Karounda	2,758 (39.47)
Acacia senegal	Kairi	5,699 (40.82)
Capparis sepiaria	Heens	2,941 (41.09)
Azadirachta indica	Neem	4,688 (41.68)
Sasbania sesban	Jhot	1,011 (43.38)
Dalbergia sissoo	Shisham	2,482 (43.51)
Ficus religiosa	Peepal	1,746 (44.4)
Holoptelia integrifolia	Chudail papdi	1,379 (51.02)
Pongamia pinnata	Papdi	368 (58.66)
Acacia nilotica ssp. *indica*	Babool	735 (62.34)
Leucaena leucocephala	Su Babool	460 (70.77)
Capparis decidua	Kareel (Teet)	1,655 (83.68)

FROM WM -1

CREATION OF NEW ARTIFICIAL WATERHOLES

Sr. No.	Category	Year	Location	Cost	Performance
1	2	3	4	5	6

Note: Category : Masonry anicut, earthen bund, lines depression, borewell and pump, reservoir, spring fed, guzzler, aquifer; permanent or temporary
Location : by compartment or by a named feature and name given if any
Performance : Successful, partially successful, failure (give reasons for the latter two)

FROM WM- 2

MAINTENANCE OF WATERHOLES: NATURAL

Sr. No.	Category	Perennial or seasonal	Location	Year	Nature of work	Cost	Performance
1	2	3	4	5	6	7	8

Note: Category : Spring, seep, natural depression, a flowing stretch, reservoir
Location : By compartment or by a named feature and name given if any
Nature of work : Desilting, provision of apron, any other category
Performance : Successful, partially successful, failure (give reasons for the last two)

FROM WM- 1.2

MAINTENANCE OF WATERHOLES: ARTIFIICAL

Sr. No.	Category	Perennial or seasonal	Location	Year	Nature of work	Cost	Performance
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Note: Category : Masonry anicut, earthen bund, lined depression, borewell and pump, spring fed, tanker fed, guzzler, aquifer etc.

Location : By compartment or by a named feature and name given if any

Year : Year of maintenance, with year of establishment in parenthesis

Nature of work : Desilting, grouting, repairing leaks, repair to mechanical parts, closing anicut openings, any other work.

Performance : Successful, partially successful, failure (give reasons for the last two)

FROM WM- 2

RESTORATION OF HABITAL: WEED CONTROL, INITIAL OPERATION

Sr. No.	Location & name of site	Year	Extent of area (ha)	Species of weed	Operation	Total cost	Cost per ha	Remarks
1	2	3	4	5	6	7	8	9

Note: Location : By compartment site name or land feature
Operation : Uprooting, cutting, burning, ploughing, manual or by using animals or machinery
Remarks : Measure of success and/or problem faced.

FROM WM- 2.1

RESTORATION OF HABITAL: WEED CONTROL, SUBSEQUENT OPERATIONS

Sr. No.	Location & name of site	Year	Extent of area (ha)	complete or partial coverage	Species of weed	Operation	Total cost	Cost per ha	Remarks
1	2	3	4	5	6	7	8	9	10

Note: Location : By compartment site name or land feature
Operation : Uprooting, cutting, burning, ploughing, manual or by using animals or machinery
Remarks : Percent cover of weed/s before operation, problems, if any

FROM WM- 2.2

RESTORATION OF HABITAL: CONTROL OF REGENERATION OF WOODY SPECIES IN GRASSLANDS

Sr. No.	Location & name of site	Year	Extent of area (ha)	Species controlled	Operation	Total cost	Cost per ha	Remarks
1	2	3	4	5	6	7	8	9

Note: Location : By compartment site name etc.
Species controlled : List the species
Operation : Uprooting, cutting, burning etc. manual or mechanism methods
Remarks : The measure of success, suitability of methods, problems encountred.

FROM WM- 2.3

RESTORATION OF HABITAL: PRESCRIBED BURNING

Sr. No.	Location & name of site	Year	Extent of area (ha)	Area treated	Operation	Total cost	Cost per ha	Remarks
1	2	3	4	5	6	7	8	9

Note: Location : By compartment site name or land marks

Extent of area : Total area identified for such treatment. In case of streams or gullies, the length involved

Area treated : If linear feature then quote length; otherwise area.

Operation : Structures involved such as gully plugs, trench-cum-mound, terracing, spurs and bunds etc. quote quantity nos. and cmt. of earthwork

Remarks : Mention if initial work of maintenance.

FROM WM- 2.4

RESTORATION OF HABITAL: SOIL CONSERVATION MEASURES- INITIAL OPERATIONS AND SUBSEQUENT MAINTEANCE

Sr. No.	Location & name of site	Year	Extent of area (ha)	Area treated	Operation	Total cost	Cost per ha	Remarks
1	2	3	4	5	6	7	8	9

Note: Location : By compartment site name or land marks
Extent of area : Total area identified for such treatment. In case of streams or gullies, the length involved
Area treated : If linear feature then quote length; otherwise area.
Operation : Structures involved such as gully plugs, trench-cum-mound, terracing, spurs and bunds etc. quote quantity nos. and cmt. of earthwork
Remarks : Mention if initial work of maintenance.

FROM WM- 2.5

RESTORATION OF HABITAL: PLANTING, SOWING-INITIAL OPERATION

Sr. No.	Location	Year	Extent of area (ha)	Species	Planting stock	Spacing	Operation	Total cost	Cost per ha	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**

Note: Location : By compartment or land marks and describe the site factors e.g. vegetation cover, soil perturbations etc.

Planting stock : Kind and condition e.g. root shoot, naked root seedling, seedlings in polythene bags, age or average size

Operation : Mention site preparation if any, crowbar holes, pits and pit size, trench, seed sowing (rate), tussock planting (norms), protection measures.

Remarks : Mention operational problems if any.

FROM WM- 2.6

RESTORATION OF HABITAL: RESPONSE OF PLANTINGS, SOWINGS AND SUBSEQUENT OPERATIONS

Sr. No.	Location	Year	Extent of area (ha)	Species	Survival %	Casually replacement	Operations	Total cost	Cost per ha	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**

Note: Location : By compartment or land marks
Casualty replacement: Mention planting stock by species, number &king (polythene bag, root shoot, rhizome etc).
Operation : Planting, sowing technique, protection measures.
Remarks : Operational problems, protection problems, any other useful information. Assess & mention survival percentage & growth before taking up causality replacement.

FROM WM- 2.7

RESTORATION OF HABITAL: AREA UNDER PROTECTION/ CLOSURE

Sr. No.	Location	Year	Extent of area (ha)	Description of site	Regulations of protection measures	Response	Remarks
1	2	3	4	5	6	7	8

Note: Location : By compartment or land marks

Description of site : % tree, shrub, ground cover, main species, impact of factors causing perturbations

Regulation & : Social fencing, power or other king of fencing, enforced protection by patrolling,

Protection measures fir protection etc

Response : To be recorded annually. Consider trend of regeneration, vegetation cover, change in structure and composition, wildlife use index.

Remarks : State problems or nay other useful information, including if area being used by people for specific purposes.

FROM WM- 3

ANIMALS : MEASURING TRENDS IN POPULATION (YEAR)

Sr. No.	Species	Population estimation methodology	Adult		Sub- adults		Yearlings	Fawns	Cubs	Total	Remarks
			Male	Female	Male	Female					
1	2	3	4	5	6	7	8	9	10	11	12

Note: Population : e.g pugmark, line transect, scan, roadside counts etc., area covered, sampling intensity

Estimation data treatment, extrapolation where involved. In case of indices of density o dung counts mention those figures under remarks columns; use details as pertinent. Describe age classes for each species.

Remarks : Operational problems, protection problems, any other useful information. Indices of density or dung count details to be recorded here.

FROM WM- 3.1

ANIMALS : NEW RECORDS

Sr. No.	Species	Location	Year	How discovered	Details of number, age, sex	Habitat description	Remarks
1	2	3	4	5	6	7	8

Note: Animals will include vertebrates and invertebrates.

How discovered : sighting, dead specimen, reliability of sighting, captured specimen, incontrovertible other evidence.

Number age, sex etc : As applicable to vertebrates

Habitat description : Broad habitat description such as vegetation and elements such as water, large old trees, den trees, snags, down log material. Use microhabitat descriptors only if relevant.

Remarks : Any other useful information.

FROM WM- 3.2

ANIMALS : MORTALITY OTHER THAN THAT ATTRIBUTABLE TO AN OFFENCE

Sr. No.	Species	Location	Year	Sex & age	Number	Discovered in what condition	Cause of mortality	Remarks
1	2	3	4	5	6	7	8	9

Note:	Location	By compartment, landmark etc.
	Sex & age	As per parameters for age class. Sex, if possible to identify.
	Discovered in what condition	Carcass, complete or partial, skull or any other recognizable remains collected where only some remains of an animal are found
	Cause of mortality	If known e.g territorial fight, accident, possible disease (following postmortem results). Old age, cause difficult to determine, predation etc.
	Remarks	Any other useful information.

FROM WM- 3.3

ANIMALS : MORTALITY ATTRIBUTED TO POACHING OR AN ACT OF VANDALISM

Sr. No.	Species	Location	Cause Of Mortality				Remarks
			Number	Sex	Age	Class	
1	2	3	4				5

Note: Location : By compartments or landmarks.
Cause of mortality : Whether the animal was intact or remains found, article or trophy to be recorded. Cause if known e.g. animal snared, shot or poisoned etc.
Remarks : Any other useful information, especially matters of illegal trade.