CHAPTER 2

STUDY AREA

2.1. Introduction

The *Gir National Park and Lion Sanctuary* (Latitude: 20°40' to 21°50' North, Longitude: 70°50' to 71°15' East, henceforth Gir WLS) lies in the south-western Saurashtra region of Gujarat state of India. Today, the Gir WLS has emerged as one of the India’s best protected area. Historically, it was once a princely hunting reserve of the Nawabs of Junagadh. The forest in past stretched over an area of 5000 km$^2$. Till 1877, the forest of old Junagadh state measured to 3,108 km$^2$ on the basis of the great trigonometrical survey carried out in the Saurashtra region. At present, the Gir WLS extends over an area of 1882.64 km$^2$ distributed in Junagadh, Amreli and Bhavnagar districts. In post-Independence India, the Gir WLS came within the boundaries of the State of Gujarat, under Biogeography province 4-B [the semi arid] as a sole home of Asiatic Lion (*Panthera leo persica*). The Gir forest was constituted as a *wildlife sanctuary* in 1965 for the purpose of preserving the Lions. In 1975, an area of 150 km$^2$ was declared a *National Park* and in 1978 expanded to 259 km$^2$. In 1984 the surrounding forests were declared a *Wildlife Sanctuary* and this combined area today forms the Lion Reserve with the National Park as the core area. For better management purposes the sanctuary has been divided under two management units of the protected area as sanctuary west & sanctuary east during 1983. There are many forests pockets of varying sizes adjoining the Gir WLS, are almost contiguous to the present sanctuary. In total, about 470.6 km$^2$ area is available currently, which though constitute the part of the habitat but is not included in the sanctuary. Earlier (during 1878 to 1914) the forests of Ex-Junagadh state were being managed by the revenue department but later the emphasis was given by some forest officials towards wildlife management & its conservation on priority.
Study Area

Map 2.1 Location of Gir Lion Sanctuary in Saurashtra & Gujarat as well.

Map 2.2 Location of intensive study area (ISA) in Gir Lion Sanctuary, Gujarat.
2.2 Location of the intensive and extensive study area

The Gir National Park and Lion Sanctuary covering an area of about 1412.13 km² comprising of 259 km² of National Park and 1154 km² of Sanctuary formed the extensive study for the present study. Approximately 200 km² (17%) in the Sanctuary West was selected as intensive study area for year round field work. The remaining area falls under protected and unclassed forests (526.30 ha.) The area of Greater Gir was selected for gathering of large predator-human conflict data. The Greater Gir is spread over grasslands and revenue areas of Amreli, Junagadh and Bhavnagar districts. The Greater Gir also includes approximately 413 km² of coastal areas having extensive coastal forests in Amreli district.

2.3 Geology and soil

The land configuration is mainly undulating with moderate hills, valleys and plateau. Northern part is more hilly, while southern part is relatively less hilly, with general drainage direction towards south and south-west. The hills are of volcanic origin with an altitudinal range of 83-524 msl. Nandivela Hill in Tulsi Shyam range & Charakiya Hill in Panja range have highest altitude 641.6m above msl in the sanctuary. The main geological formation is Dacca trap and main rock types are 'Dolomite' and Basalt. Beside sand stone, lime stones and metamorphic schist are also present. Volcanic rocks have given rise to the black cotton soil and sand stones, and lime stone have given rise to reddish brown sandy loam soil. Soil texture varies from gravelly along the river banks, clay in deep valleys to stony and murrum on hills. Water holding capacity is the lowest on sandy loam and highest in black clay, which remains water logged during monsoon. Soil layer thickness varies in different areas is up to 1m thick in valley areas. Wherever drainage is poor on account of higher clay content and therefore the quality of teak is poor. In such areas babul (Acacia spp.) and other scrub species grow very well. The best teak growth is seen on well drained sandy loam soil.

2.4 Drainage pattern

Gir ecosystem forms major catchments of seven rivers of which 4 rivers have been dammed. The rivers are Hiran, Datardi, Singhoda, Maehundhr, Ghodavadi, Raval and Shetrunji. Small streams criss-cross the entire Gir ecosystem & in turn join major rivers. During the dry season, water is a limited resource and restricted to perennial...
rivers, reservoirs and deep rock pools of small streams. Drainage pattern of western Gir is subdendric to parallel or trellis. This is due to dykes and the large number of fractures that cuts across area in a definite pattern. In the eastern Gir the drainage pattern is mainly sub parallel to trellis. At higher altitudes it is radiating and dendritic. A prominent stream in the central part of western Gir forms a gorge. A major part of the area that lies to the south of these water divides is drained by various rivers like, Dhatardi, Ardak, Shinghoda and tributaries of Hiran in the west; and tributaries of Jamri and Ravel in the east.

2.5 Climate

Gir ecosystem has hot climate with an erratic tropical monsoon. Three seasons viz. summer, winter and monsoon are distinct. Late November to early March is cool & dry followed by hot season from mid March to July. The temperature drops down to about 10°C in winter and rises to about 43°C in summer. Mid June to September is monsoon period and bulk of precipitation is received during July and August. Rainfall data of past 28 years received at Kamleshwar in western part of Gir and Raval Dam in eastern part of Gir show that average rainfall is 1000mm and 600mm respectively. Wind blows mainly from north-west to south-east during October to March and changes south-east to north-west during summer and monsoon. Eastern portion of Gir is more arid than western Gir.

Summer: The summer seasons sets in the month of March and lasts till around June when the area receive the first shower of monsoon. April and May are the hottest months of this area and the mercury may shoot up to 44 °C. There is a general reduction in the water availability throughout the Gir WLS, barring a few perennial water-courses, streams and waterholes in the lower areas. These seasonal fluctuations pose a great deal of managerial problems. The management of artificial waterholes in dry season is not a serious problem in the good rain year but in a year with less and erratic rain becomes a major management focus. Gir remains prone to accidental ground fires and it is common at this time of the year. Despite precautions and a very effective fire protection strategy, almost every year some parts of Gir WLS face accidental fires. Such manmade fires usually originate from the outer peripheral areas close to the PA boundary.
Monsoon: The monsoon arrives with pre-monsoon showers usually received in first week of June and regular rain start with the onset of south west monsoon in the month of July and lasts up to September and a few showers are also received in October. The onset of rains transforms the entire Gir LS landscape into a lush green condition and humidity goes up to 90 percent. Due to irregular monsoon and uneven distribution of rainfall, drought years are not uncommon.

Winter: The winter season sets in November and lasts till February. December and January are the coldest months. In winter, night temperature goes down. Riverine habitat has generally very low temperature during night hours. A thin layer of fog covers the area, particularly along the streams during early hours and the incidence of dew become heavy. The leaf fall sets in towards the end of winter and the deciduous trees remains leafless until shortly before the break of monsoon and only few tree species renews its foliage almost simultaneously with the fall.

2.6 Flora and habitat types

The pattern of flora varies in all aspects from west to east axis. According to Champion and Seth (1968) revised classification of forest types, the area falls under the type 5A/Cia, i.e., very dry teak forests. Teak occurs mixed with dry deciduous species. Qureshi & Shah (2004) updated the flora of Gir WLS has categorized them into 3 broad habitat types: Moist Mixed vegetation, Thorn Forest, and Hill Forest, which were further divided into eight types. They use Geographical Information System (GIS) at coarser resolution, a level for studying the response of ungulates to habitat. Apart from natural vegetation the water bodies (reservoir, rivers, ponds, and lakes), agriculture fields, orchards within Gir LS was also considered.

i. Moist Mixed Vegetation

Moist Mixed Forest: The dominant species in western part is Tectona grandis which is replaced by Anogeissus spp. and Acacia spp. in eastern part of Gir WLS. The associated dominating species are Acacia spp., Wrightia tinctoria, Syzygium spp., Mitragyna parvifolia, Bauhinia racemosa, Diospyros melanoxylon, and Emblica officinalis. The lower crown comprises of Acacia spp., Zizyphus spp., Grewia tiliaefolia, Helicteres isora, Carissa confestas, Manilkara hexandra, and Ixora arhorea.
Mixed Forest: The dominant species in west is *Tectona grandis* which is replaced by *Anogeissus spp.* and *Acacia spp.* in eastern part. The associated species are *Diospyros melanoxylon*, *Garuga pinnata*, *Gmelina arborea*, and *Mallotus phillipensis*. The under storey comprises of *Zizyphus spp.*, *Acacia spp.*, *Wrightia tinctoria*, *Grewia tiliaefolia*, *Helicteres isora*, *Carissa carandas*, *Manilkara hexandra*, and *Capparis sepiaria*.

ii. Thorn Forest

*Tectona* in west (replaced by *Anogeissus spp.* in the east) – *Acacia – Zizyphus*.

The co-associates are *Acacia spp.*, *Tectona grandis* (replaced by *Anogeissus spp.* in east.), *Zizyphus spp.*, and *Terminalia spp.*, and the under storey with *C. congesta*, *C. sepiaria*, and *Zizyphus spp.*. *Acacia spp.* - *Zizyphus spp.* Thorn forest association *Acacia spp.*, *Zizyphus spp.* with co-associates like *C. sepiaria* and *C. congesta*.

Scrubland: This association is characterised by patchy and stunted growth of scrub species like *A. catechu*, *A. leucophloea*, *Zizyphus numularia* with co-associates such as stunted *Zizyphus spp.*, *C. sepiaria* and, *Balanites aegyptica*.

Savanna: Scattered growth of trees like, *Acacia spp.*, *Zizyphus spp.*, *T. crenulata*, *B. racemosa*, *T. grandis*, *Anogeissus spp.* *Boswellia serrata*, and *Balanites aegyptica*. The grasses like *Apluda mutica*, *Heteropogon contortus*, *Themeda quadrivialis* and *Sehima nervosum* forms the ground layer.

iii. Hill Forest

*Acacia – Anogeissus* (*Tectona* replaces *Anogeissus* in west Gir): The co-associate species are *Acacia spp.*, *Anogeissus latifolia*, *Terminalia spp.*, *W. tinctoria*, *G. tiliaefolia*, *Boswellia serrata*, *Flaucoria indica*, *B. racemosa*, and *Zizyphus spp.*

*Acacia - Lannea - Boswellia* The association is characterised by *Acacia spp.*, *Lannea coromandelica*, *B. serrata*, *T. grandis*, *T. crenulata*, *W. tinctoria*, *Soymida febrifuga* and *Sterculia urens.*
The composition of important tree species of Gir WLS in descending order is -
*T. grandis* (31.3 %), *Wrightia tinctoria* (11.2 %), *A. catechu* (9.2 %), *Zizyphus mauritiana* (7.5 %), *A. nilotica* (4.2 %), *Anogeissus latifolia* (3.9 %), *A. leucophloea* (3.4 %), *Terminalia crenulata* (3.1 %), *Diospyros melanoxylon* (2.4%), *Bauhinia purpurea* (2.4%), *Grewia tiliaefolia* (1.9 %), *A. fereginia* (1.8%), *Boswellia serrata* (1.7%), *Lannea coromandelica* (1.5 %), *Butea monosperma* (1.3 %).

2.7 Diversity of fauna

Gir WLS has rich fauna assemblage which includes 39 species of mammals, 37 species of reptiles, about 300 species of birds and more than 2000 species of insects. In Gir ecosystem the main carnivore species are Asiatic lion (*Panthera leo persica*), leopard (*Panthera pardus*), jungle cat (*Felis chaus*), striped hyena (*Hyaena hyaena*), jackal (*Canis aureus*), mongoose (*Herpestes edwardsi*), small Indian civet (*Viverricula indica*), fox (*Vulpes bengalensis*), ratel (*Mellivora capensis*), and desert cat (*Felis libya*). Chital (*Axis axis*), nilgai (*Boselaphus tragocamelus*), sambar (*Cervus unicolor*), four horned antelope (*Tetracerus quadricornis*), and chinkara (*Gazella gazella*) constitute the major wild herbivores of the Gir. Wild boar (*Sus scrofa*) also widely distributed in PA. The smaller mammals like common langur (*Presbytis entelhus*), porcupine (*Hystrix indica*) and hare (*Lepus nigricollis*) are common but pangolin (*Manis crassicaudata*) is rare. Marsh crocodile (*Crocodilus palustris*) is found in the four big dams within the PA as well as in the main rivers and some of their tributary, make largest population in a single place in Gir LS. The star tortoise (*Geochilons elegans*), monitor lizard (*Varanus bengalensis*) and number of snakes are also common. Indian rock python (*Python molurus*) is rarely encountered and sometime met with along the stream banks. The main predator birds of Gir WLS are the great horned owl (*Bubo bubo*), the spotted owlet (*Athene brama*), the tawny eagle (*Aquila rapax*), Shikra (*Accipiter badius*), brahminy kite (*Heliastur indicus*), the black winged kite (*Elanus caeruleus*) etc.

2.8 Maldharis (Mal-livestock and Dhari - guardian)

‘Maldharis’ are the devoutly religious pastoral communities of human beings and they constitute a part of Gir WLS, for over 125 years. They occupy 129 small settlements
called “nesses” scattered all over the Gir forest. Currently there are 4800 individuals along with 16,852 domestic livestocks. The domestic livestock is comprised of buffaloes and cows, though they also possess camels which are mainly used for transport. Their animals are kept together during night in circular thorn fencing and are let loose into the surrounding forests for grazing throughout the day. The maldharis and their livestock exert negative impact on Gir habitat due to consumptive use of both forest products and fodder. The practices such as cutting and lopping of trees for house construction and fodder for livestock, adversely affect the vegetation and the practice of mixing up of top soil and buffalo dung from 1 km radius around the ‘nesses’ for sale to outsiders as manure deprives the forest soil of nutrient recycling vital for rejuvenation of the ecosystem. To reduce negative impact of maldharis on Gir ecosystem Maldhari’s resettlement scheme was implemented in 1972.

2.9 Forest settlement villages

The Nawab of Junagadh permitted settlement of some permanent labourers in the forests due to inaccessibility of Gir forests. They were granted forest land on lease for cultivation and other purposes in open areas. In addition, they were also given timber for construction of their houses in these forest settlements. At present, there are 14 forest settlements with 556 households with a total human population of 4874 and of about 4241 livestock existing in Gir forest. An area of 18.66 km² has been given as settlement land to the cultivators. “One of these, the Shirvan forest settlement village within the PA and approximately 13 kms from Sasan is a settlement of Sidhis, who are of African origin and are classified as schedule tribes. Their main occupation is agriculture. All these forest settlement villages form part of the sanctuary.

2.10 Peripheral villages

There are 97 villages within a radius of 5 km from the sanctuary area. The boundary of sanctuary falls in seven talukas of Amreli and Junagadh districts. These talukas are Dhari, Khambha, Una, Talala, Malia, Mendarda and Visavadar. The main occupation of these villagers is agriculture and animal husbandary. The agricultural land surrounding Gir is fertile and hence there is a constant pressure on the forest for encroachments. The agriculturists keep livestock in moderate number. The landless people also keep livestock. These communities are prohibited to graze their livestock.
in the sanctuary or collect forest produce from the sanctuary. Out of total human population of 1,52,000 in 97 villages there are 23,000 farmers, with 95,000 livestock.

2.11 Grazing practices

Stall feeding is practiced for milk animals only, whereas most of the cattle depend on gauchar, waste land and protected forest for grazing. There is a constant pressure on the Gir WLS from these cattle during monsoon for grazing.

2.12 Large predator human conflict (LPHC)

Gir exists as a forest ecosystem with an interface with large human and cattle population which results with frequent man-animal encounters. Normally animals do not come into conflict with human population, but certain situations such as unprecedented increase in human and livestock population and changes in cropping patterns have increased the frequency and intensity of interaction which results into economic losses and human risk as well. The human activity abruptly starts with intense concentration at the legal boundary of Gir LS whereas wildlife dispersal reaches beyond administrative boundary following ecological gradient. There is also a considerable pressure on Gir ecosystem from the human beings residing in and at periphery for their requirements of timber, fuel wood. Other forest product includes small timber, firewood, grass, amla, aritha and other fruits and honey etc.

2.13 Land use pattern

Agricultural land occupies almost half (50%) of the geographical land in the state. Of total geographical area only 6% (196117 km²) is available as forest land while 35% is under cultivation practices. Semi-Arid forest ecosystem of Saurashtra has further been divided in eight agro-climatic zones. According to agro-climatic regional planning unit (ARPU) the Gir WLS falls under ARP number 6 & 7 agro-climatic zone. Around Greater Gir, the main land use is agriculture with good irrigation facility.

Saurashtra has approximately 37379 km² of area under cultivation of major crops. The region produces a large variety of crops where higher percentage of the land is used for cultivation in western Gujarat. Junagadh, Amreli and Bhavnagar districts are the main contributors to the agricultural production of the state. Major crops include
cereals like rice, wheat, jowar, bajra, maize, ragi, pulses like tur, mung, moth, udad, oil seeds like groundnut, sesames, seed and mustard, castor, cash crops like cotton, tobacco, sugarcane, & horticulture crops. The yield of cotton actually is the highest in the country.

i. Sugarcane was cultivated in these areas till 80s which stopped after that but since last ten years it is in practice. Irrigation facility is inadequate in these districts to cultivate this annual crop. As many as 30,000 check dams built in the region have helped in recharging ground water. Farmers of Jamka village in Junagadh built 51 check dams in 1995 without any government grant. This has resulted in the farmers of Jamka reaping rich sugarcane crops during the last two years. The farmers in Amreli, Jamnagar and Rajkot are also benefiting a lot (Agriculture Department, Gujarat State).

ii. Mango orchards. In Saurashtra, Bhavanagar, Junagadh (7 km² area under mango plantation) and Amerli (1km² area under mango plantation) districts are the key mango growing districts in the state. Bhavnagar and Junagadh constitute about 13 percent of total area of the state under fruit production. Saurashtra alone covers about 32 percent of the area under mangoes in the state. This area is known for the production of famous Kesar mango which brought Gujarat at the 7th position in India. State shares 6.16% production of the country and has mango plantations on 1 lakh hectares. Both the area and production has registered an increase over the previous year (1996-97) when the area and production accounted for 135.5 ha and 1820 MT/ha in account of the state respectively. Consequently, mango productivity depicts increase from 1820 to 77210$ T per ha from 1998-2007. A perusal of area under mango in the state indicated that it has been growing almost linearly over the years.

iii. Ground nut & Sesame (48% & 7%; 2004) are the principal oilseed crops of Saurashtra region of Gujarat state. These crops have achieved impressive growth in agricultural production of this region during last three decades and being cultivated throughout the saurashtra mainly for the oils (refined and vanaspati). In the Saurashtra, cultivation of oil seeds is most prominent as it covers 70 percent of the total oil seeds production area in Gujarat. The state is the leading state for highest production of the groundnut known as the “Peanut Bowl” of the India makes the state as leading state for its production; contributing 27% of the country’s production but at state level, 93% is the share of Saurashtra.
iv. **Cotton** yield is well below the world average yield, because more than 70% of crop is rain fed. This holds true for Saurashtra cotton, which produces 54% of Gujarat's cotton production. In Saurashtra average productivity in the rain fed area is 225kg/ha, whereas in the irrigated field it is 450kg/ha. In total production of major crops it has estimated 24% production in Saurashtra only. Hence, with the assured irrigation facilities there is scope for productivity enhancement. Till recently, all efforts in cotton industry were to increase productivity.

### 2.14 Industries

According to GIDB final report (2006) large scale industrial development has taken place during recent past along the coastal belt near the Gir and many giant industrialists have plans to set up industries. The Ambuja cement at Kodinar and the GHCL at Sutrapada constitute the major industries. The cement manufacturing plant mainly sustains upon lime stone which is quite abundant in the surrounding areas. With a view to giving protection to the reserved forest i.e. PA from outside influences, the areas around the forest and adjacent to the surrounding villages were declared as protected forest. With Forest (Conservation) Act, 1980 coming into force, all activities including mining in these areas also were prohibited and hence, presently the extraction of lime stone is confined to the areas outside the forest only. Expansion of industries has also threatened coastal forest which is the new habitat for big cats.

### 2.15 Organisation of Gir National Park & Lion Sanctuary

Gir Protected Area is being conserved by following administrative units: social forestry division Junagadh, normal division Junagadh, normal division Bhavnagar, Social forestry and two territorial units Gir (west), and Gir (East) with head quarters at Junagadh district and Amreli district (Dhari) respectively. Gir WLS has ranges, 60 rounds and 152 beats to deal with problems such as illicit cutting, illegal grazing and poaching of wild animals as there is a considerable pressure on Gir forest from people living in and around the forest for their timber, fuelwood and MFP requirements.
Figure 2.1 Percentage contributions of habitats and plants categorized in Gir Lion Sanctuary, Gujarat.
Map 2.3 Different habitat types of Gir Lion Sanctuary with one km buffer. (Source: Wildlife Institute of India).
Map 2.4 Drainage patterns of Gir Lion Sanctuary, Gujarat.
Map 2.5 Present locations of maldhari masses and settlement villages in Gir Lion Sanctuary, Gujarat.