

# **GREATER GIR ECOSYSTEM: ECO-RESTORATION OF GIRNAR FOREST & RECAPTURE OF LOST TERRITORY BY *PANTHERA LEO PERSICA* (ASIATIC LION)**

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## **ABSTRACT**

The Asiatic Lion (*Panthera leo persica*) once roamed freely in central Europe and west Asia. It migrated to India and is presently confined to the Gir Forest, in the semi-arid region of western India. Although, it once ranged throughout the whole of central and north India, by 1880, its population had dwindled to about 12. Since then, sustained conservation measures, including formation of the Gir Protected Area (PA) in 1965, increased the population of Asiatic Lions to 305 by 1995. Since all wild Asiatic Lions were confined to Gir PA, it was felt that another suitable habitat should be established to reduce inbreeding and prevent extinction of the species. In Girnar forest, a 180 km<sup>2</sup> patch of degraded forest, about 60 km from Gir, the Asiatic Lion was reported to be present until 1963, but later the whole population disappeared due to destruction of forest and loss of habitat. In 1992, determined eco-restoration efforts, combining watershed development and habitat protection with people's participation and a campaign to increase public awareness, resulted in regeneration of the degraded forest. The habitat improved beyond recognition, with increased populations of herbivores. Asiatic Lions that migrated from Gir recaptured the lost territory. Within 3 years, the lion population rose to 13 and now many cubs have been observed in Girnar. During this period, Asiatic Lions have made Girnar forest their permanent home and the population, along with herbivores, is on the increase. Of course, this has resulted into a new set of problems, because Girnar forest is located at the doorstep of Junagadh City and encompasses many religious places. Eco-restoration of Girnar forest and the return of the lions to other neighbouring areas have increased lion habitat from 1,400 to 2,000 km<sup>2</sup>. This approach and the success of Girnar provide a model for other regions, where local economic interests and forest restoration can be combined with restoration of habitat and faunal diversity.

## **INTRODUCTION**

The Asiatic Lion (*Panthera leo persica*) is confined to the Gir forest of Gujarat, in the western part of India (Map I). Low and erratic rainfall and extreme temperatures characterise the whole region, which is popularly known as Saurashtra and also Kathiawar,

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thus failing in the semi-arid zone. The region is drought prone and is often affected by cyclones and floods, since it is a peninsula surrounded by the Arabian sea on three sides. Gir forest, which is a dry deciduous teak forest, has been declared a Protected Area (PA) and thus varying degrees of protection and management are applied for managing the National Park and Sanctuary. The central part of the Gir forest comprising 258.71 km<sup>2</sup>, has been declared a National Park (NP) and the surrounding area of 1,153.41 km<sup>2</sup> is a Sanctuary. In the National Park, all human activities are prohibited unless permitted for some specific purpose, whereas in the Sanctuary, many human activities are allowed unless specifically prohibited by the management.

#### GIR FOREST: LAST ABODE OF THE ASIATIC LION

The Gir forest lies between the parallels of latitude 20° 40'N and 21° 50'N and meridians of longitude 70° 50'E and 71° 50'E. Gir falls in the Afro-tropical realms and '4-B Gujarat Rajwara' biotic province of the semi-arid zone. The forest area is rugged and hilly with elevations varying from 150.3 to 503.7 m above sea level. Slopes are generally moderate and the hills are of volcanic origin. The maximum and minimum temperatures are 44.4°C and 10°C respectively. Rainfall is quite erratic and irregularly distributed; the maximum annual precipitation is 186.6 cm and minimum 19.9 cm with an annual average of 98.0 cm. Wind blows mainly from north-west to south-east during October to March, changing to south-east to north-west during summer and monsoon.

#### Location of the Gir

Although the Gir forest is known as the last abode of the Asiatic Lion, it is also very rich in flora and other fauna. In this region, Gir is considered important for the conservation of not only biological diversity but also for the cultural diversity of the region. Due to a variety of reasons, much research and study has not been done on Gir, but as per available information, there are 450 recorded flowering plant species, 32 species of mammals, 26 species of reptiles, about 300 species of birds and more than 2,000 species of insects. The forest also harbours a variety of endangered and threatened species, and provides breeding grounds for many migratory and resident birds. In the 1,412 km<sup>2</sup> PA, there are two major carnivores i.e. Asiatic Lion (*Panthera leo persica*) and leopard (*Panthera pardus*), together numbering more than 500. Other carnivores are hyena (*Hyaena hyaena*), fox (*Vulpes benghalensis*), jackal (*Canis aureus*), jungle cat (*Felis chaus*), desert cat (*Felis libyca*), mongoose (*Herpestes edwardsi*) civet cat (*Viverricula indica*) and ratel (*Mellivora capensis*). The area is abundant with herbivores, viz. spotted deer (*Axis axis*), sambhar (*Cervus unicolor*), bluebull (*Boselaphus tragocamelus*), wild boar (*Sus scrofa*), four-horned antelopes (*Tetracerus quadricornis*), chinkara (*Gazella gazella*), etc. Other major animals found in the area are common langur (*Presbytis entellus*), porcupine (*Hystrix indica*), hare (*Lepus negricollis*), crocodile (*Crocodylus palustris*), pangolin (*Manis crassicaudata*), python (*Python molurus*), Star tortoise (*Geochilon elegans*), monitor lizard (*Varanus*

*bengalensis*), rusty spotted cat (*Felis rubiginosa*), etc. In India, Gir has probably the highest number of crocodiles and also has the highest population of spotted deer, numbering more than 32, 000 in the year 1995.

In the forest and surrounding areas, a huge population of cattle competes with wildlife for space, water and food. Bordering the Sanctuary, 97 villages within a periphery of 6 km, have more than 100,000 cattle. The villagers are totally dependent on the PA for their livelihood, including water, fodder, grass, soil and fuel-wood. There is a local tribe, called the Maldharis (cattle owners), who are basically pastorals and generally are known for practising a nomadic life. Their main livelihood is cattle rearing and selling milk and other dairy products. Thus they are dependent on resources within the PA for their day-to-day survival. As per the 1995 survey, there are 54 nesses (settlements) with 361 families of Maldharis inside the Sanctuary. In the National Park, there is no nesses. In addition, there are 14 forest settlement villages, covering an area of 5,176.44 ha. with 556 households and a population of 4,494 people and 4,242 livestock. Ever since their forefathers were settled in the area by the then Nawab of Junagadh to provide local labour in the forests, they have become accustomed to relying on the PA's resources.

In the coastal region many industries, such as cement and sugar, are dependent on the Gir forest for water. In fact, this forest is the major source of water to the whole region and 4 reservoirs have been built inside the PA. These reservoirs are a perennial source of water. During summer, they provide excellent habitat for ungulates, crocodiles, etc. Also many small dams and reservoirs have been built on the periphery of forest to store water for agriculture and domestic purposes.

Table I Wildlife Populations in Gir

S. No.	Name of animal	Population in the census year					
		1969	1974	1979	1985	1990	1995
1.	Asiatic Lion	-	180	205	239	284	304
2.	Leopard	-	155	161	201	212	268
3.	Hyaena	-	74	84	192	97	137
4.	Spotted Deer	4,100	4,517	8,431	10,466	27,600	32,061
5.	Sambhar	600	706	760	772	1,764	2,262
6.	Bluebull	400	1,528	2,033	2,081	1,524	1,856
7.	Chousingha	100	969	1,042	1,963	427	441
8.	Chinkara	50	195	330	311	972	387
9.	Wild boar	300	1,922	2,365	2,212	505	1,214

Based on regular censuses Table I. clearly shows an increase in the wildlife. This success has become the main cause of man-wildlife conflict, as all are competing for the limited space and resources of the PA.

## ASIATIC LIONS AND THEIR POPULATION

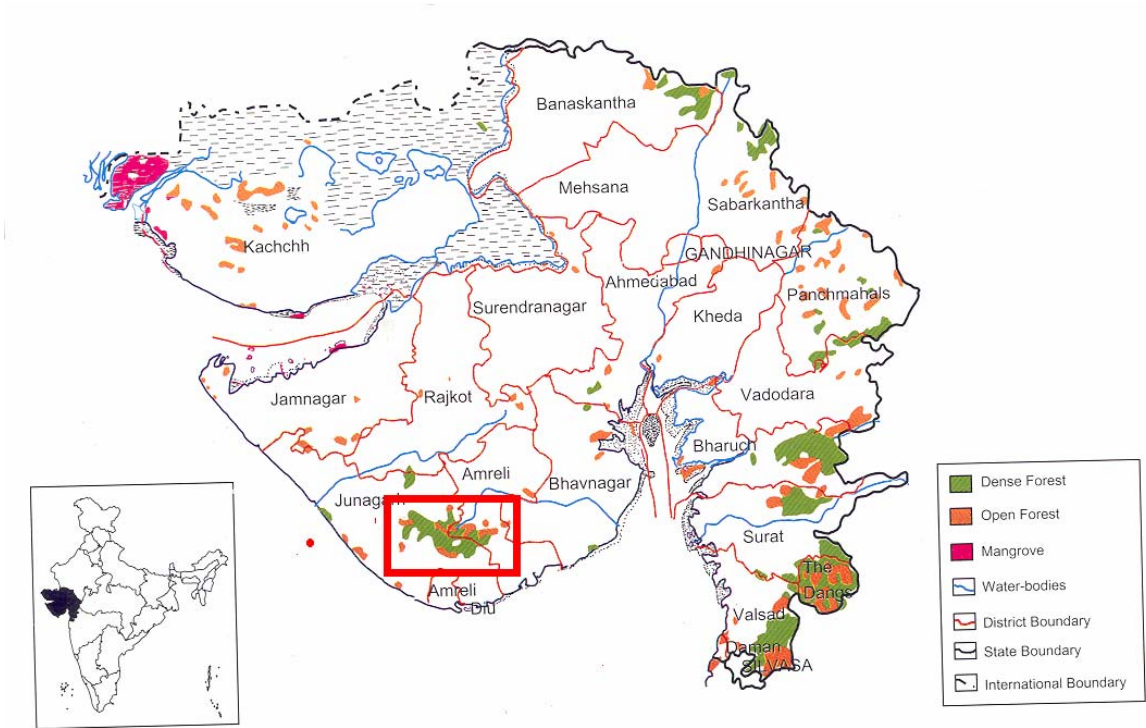
The Gir forest is known all over the world as the last abode of Asiatic Lions. Asiatic Lions were once widely distributed in Asia covering Mesopotamia, Arabia, Persia and the Indian subcontinent, where the species was fairly well distributed until the end of 18<sup>th</sup> century. The lions roamed throughout West and South Asia, entering India through the northwestern passes. They ranged over practically the whole of the northern and central part of the country, extending from Sindh (Pakistan) to Bengal and from the Ganges and the Indus to the northern bank of the river Narmada. Before the end of 19<sup>th</sup> century, the Asiatic Lion had become extinct from its whole range except the Gir. The probable years of its region-wise extermination are Bihar (1840), Delhi (1834), Bhagalpur (1842), eastern Vindhya and Bundelkhand (1865), Central India and Rajasthan (1870) and western Aravallis (1880). Outside Saurashtra, the last surviving animal in the wild was reported in 1845. By the end of 19<sup>th</sup> century, the then Nawab of Junagadh indicated the number of lions to be about a dozen in the Gir. Probably, this low number was reported to save the lions from further extermination.

Lions struggled to survive during the severe drought and famine between 1901 to 1905, by killing many humans and livestock. In spite of this, the Nawab of Junagadh provided adequate protection to the animals and the population thus increased between 1904 to 1911. After the death of the Nawab, 12–13 lions were being shot annually. From the year 1911 onward, the British authorities rigidly controlled shooting, and during the year 1913, the Chief Forest Officer of Junagadh reported that there were not more than 20 lions left in wild. Gir was connected with the Girnar and Mitiyala hills by rough and semi-wooded corridors. Similarly, the area was also connected with the Barda and Alech hills and a wild wooded strip between Dhank and Chorwad along the seacoast. This enabled the Gir lions to roam freely through these pockets.

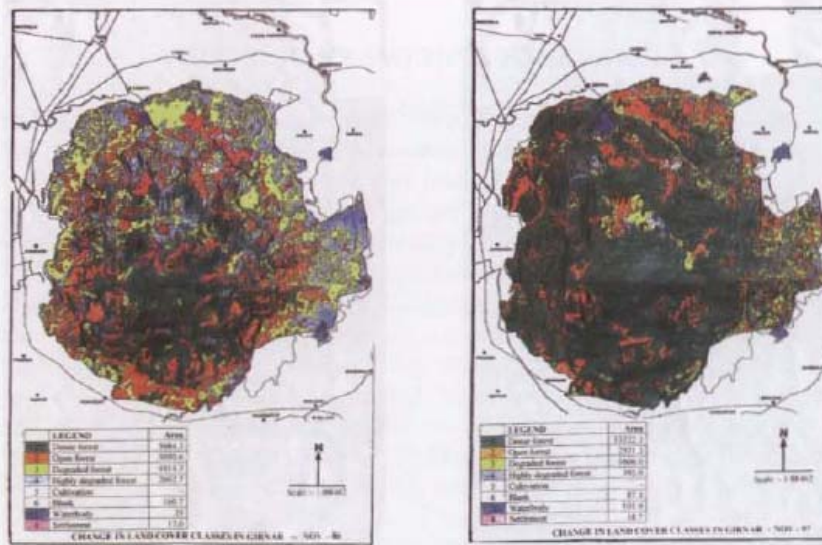
In the later half of 19<sup>th</sup> century, Asiatic Lions deserted the Barda and Alech hills, probably due loss of habitat and continuous disturbance caused by the British Army pursuing Wagher outlaws hiding in these hills. In 1879, a pride, consisting of a male, a female and a cub, was last seen in that area. However, before the then Porbandar State could take steps to protect these animals, the Rabaris and Nawanagar State police stationed there killed them.

Table II Estimated Asiatic Lion populations in the past

Year	Authority	Total
1880	Col. Watson	About 12 (E)
1893	The then Junagadh State	About 31 (E)
1905	Maj. Carnegy	About 60-70 (E)
1905	The then Junagadh State	About 100 (E)
1913	Mr. Wrangler	Not more than 20 (E)
1920	Mr. P. R. Cadel	About 50 (E)
1920	Mr. Ratnagar	At least 100 (E)



Map I Location of the Gir Forest



Maps showing an increase in dense forest (green) and decreases in open and degraded forests (orange and yellow) following eco-restoration at Girnar 1986-97.



Degraded Girnar forest in 1991, just before eco-restoration was launched

Naturally regenerated teak after integrated watershed development.



Asiatic Lions started appearing in the Mitiyala forests from 1917 onwards. Twenty-three lions were shot there between 1940 and 1946. Lions were last seen in small numbers in the Girnar hills adjoining Junagadh until 1963. Nine lions were captured there between 1944 and 1958. The roaring of captive lions kept in the Sakarbag zoo, located at the foothills of Girnar and maintained by the Forest Department often attracted wild lions. However, no lions were recorded from this area after 1963 until a few stray individuals were again located there during the 1974 census.

Table III Asiatic Lion populations based on census.

Year	Number of					Cubs	Total	Authority conducting the census
	Adults		Sub-adults					
	Male	Female	Male	Female				
1936	143	91	-	-	53	287	Junagadh State	
1950	179	187	-	-	40	219-227	Mr. Wynter Blyth	
1955	144	100	-	-	49	290	-do-	
1963	82	134	-	-	69	285	Gujarat Forest Department	
1968	60	64	-	-	51	177	do-	
1974	40	52	13	25	50	180	-do-	
1979	52	68	13	14	58	* 205	-do-	
1985	66	75	27		48	239	-do-	
1990	99	95	-	-	63	284	-do-	
1995	94	100	18	21	71	304	-do-	

\* In 1979, total 50 sub-adults were seen but sex of the animals could not be identified.

Recorded history shows that in 1880, the Asiatic Lion population was reduced to 12. This alarming decline in population catalysed conservation measures. Once the Gir Sanctuary Project (1972) was implemented, the population of Asiatic Lions and other fauna grew steadily (Table I). This increasing population of all wild animals exacerbated wildlife-human conflicts. In fact, the situation reached the stage where Lions started visiting neighbouring villages and killing livestock.

**The Gir Lion Sanctuary Project:** The study conducted by JOSLIN (1972) and BERWICK (1972), revealed startling facts about the causes of decline in biological diversity, including the lion population in Gir. In view of these studies, the Gir Lion Sanctuary Project was launched in 1972, resulting in considerable improvement of habitat, despite a catastrophic cyclone in 1982 and severe droughts in 1987 and 1988. Due to clear policies and strategies, combined with research input and ensured participation of local people, the Gir PA has become one of the best managed Protected Areas in the country.

**Predation pattern:** JOSLIN'S study in 1969 revealed that 75% of food for lions came from predation of domestic livestock and only 25% was wild ungulates. Since 1969, especially after the implementation of the Gir Lion Sanctuary Project, conditions and habitat have changed drastically. All nesses in the National Park and the majority in the Sanctuary

have been shifted outside the Gir. After strict control on grazing by domestic livestock, there has been a dramatic change in the habitat, resulting in a steep increase in ungulate populations, especially of spotted deer. In 1990, a study conducted by CHELLAM revealed some interesting facts about changes in the predation patterns of the lions. Scat analysis revealed that only 25.9% of items identified in lion's scats were livestock, indicating almost complete reversal in the predation pattern. About 75% of scats collected from areas outside the PA had livestock remains. In these cases, remains of wild ungulates were also detected. A seasonal pattern was also observed in the composition of lion kills during the monsoon and post-monsoon, which is probably due to changes in the density of vegetation. Furthermore, lions kill more spotted deer and Sambhar stags than was expected in the Gir. The diets of lion and leopard in Gir have an overlap value ranging from 0.61 to 0.71, with spotted deer being the top ranking prey for both carnivores. Within a period of 25 years, there has been a complete reversal in the predation patterns of lions in the Gir, which is probably because of changes in the availability of prey species and adaptability of the lions. The flexible nature of the Asiatic lion became very important for its survival even outside the Gir and colonising new areas.

**Lion Home Range & Migration:** During the monsoon, lions tend to move away from the interior dense Gir forests to more suitable open forest areas to escape flies and mosquitoes due to excessive humidity and dense growth. Migration of Asiatic Lions towards the coastal belt started in 1987–88. Similarly, during the early 90's, lions started frequenting Girnar as well as Mitiyala forests. A study by S. P. Sinha has revealed that a lion pride has a fairly well defined home range. One adult male lion has approximately 48-57 km<sup>2</sup> as a home range, whilst for adult lionesses, the range is about 20-25 km<sup>2</sup>. Up to 15% of pride ranges overlap. However, CHELLAM (1992), using radio collars, showed that in the dry season, the home range of females was 84 km<sup>2</sup> and in the monsoon, it was 67 km<sup>2</sup>. For males, it varied between 144 to 201 km<sup>2</sup>. Dispersal of lions from Gir can be attributed to a population increase in the Gir forest.

## GIRNAR FOREST

Gir and the surrounding forest areas are socio-economically very important because they provide sustenance to people especially during times of drought and resultant scarcity, which are quite common. About 60 km from the Gir forest, lies the Girnar (meaning 'king of mountains'), 18,000 ha of dry deciduous and dry scrub patches on mountainous, rocky terrain, on the doorstep of Junagadh city and surrounded by 39 villages. This patch of forest is the traditional water source of Junagadh City and neighbouring villages. The population of the city is estimated to be more than 250,000. In the past, Girnar forest was a dense, dry teak deciduous forest, comprising mainly teak, bamboo, *Acacia* and other associated species. The highest peak in the Girnar is more than 1,100 m above MSL and there are many hills and hillocks.

In the Girnar hills, there are many religious places. More than 1.6 million people visit the forest/ hills annually to offer their prayers to various deities. Every year, in November, people walk completely around one of the main hills, Girnar Parikrama, in the belief that

after death, they will attain Moksha i.e. complete release from the birth and death cycle. Similarly, in February–March, people come to celebrate Shivaratri (the night of Lord Shiva, God of destruction, in Hindu Mythology). Also, once a year, very large numbers of Muslim (as well Hindu) devotees come to offer their prayers. Girnar is also considered a holy pilgrimage for followers of Jainism, another Hindu religion.

#### ISSUES AND PROBLEMS IN THE AREA

In the 1970's & 80's, the forest was ruthlessly exploited by illegal tree felling for timber, fuel-wood and bamboo. In many parts of the forest, legal as well as illegal mining also started. Due to a ban on liquor in the state and the proximity of the forest to the adjacent city, bootleggers started using Girnar and its various resources, such as water, dead and dry fuel-wood and undulating terrain, for making illicit liquor. This caused immense damage to habitats, as quite often it led to forest fire, continuous disturbance and loss of water sources. Uncontrolled grazing and illegal cutting of trees for timber and bamboo, coupled with encroachment and mining caused rapid degradation of the forest. In fact, frequent and extensive forest fire became commonplace. At this stage, staff and officials responsible for management and development of the Girnar forest were highly demoralised. Woodcutters were so organised that they started attacking patrolling staff and incidents of attack on forest staff increased alarmingly.

Forest fires in Girnar and Gir reached such an alarming level, such that the Government had to appoint a High Powered Committee to identify the causes of fire and suggest remedial measures. The Committee included people's representatives as members, which went a long way to ensure the local people's co-operation and their subsequent participation in the whole eco-restoration programme. Later, the then Working Plan Officer of the region was asked to study and identify the factors responsible for forest degradation and suggest remedial measures for rehabilitation. Both these study reports became available at the end of 1991. They revealed that during the previous few decades, what was once, a very rich forest, had been degraded by illicit removal of wood, illicit distilling, mining, illegal grazing and other associated problems viz. soil loss, decreasing moisture etc. In his report, the Working Plan Officer (A. K. Sharma), identified the following major reasons as responsible for forest degradation:

1. Demoralisation of staff
2. Forest fire
3. Illegal cutting of trees by organised wood cutters
4. Non-responsive administration
5. Connivance of staff in certain cases
6. Edapho-climatic conditions
7. Lack of will to protect the forest
8. Encroachment
9. Illegal and uncontrolled grazing

The report also recommended that immediate steps be taken to arrest degradation of Girnar forest, as it had reached such a stage that any further delay in action would lead to complete loss of forest with no possibility of regeneration.

### A NEW APPROACH

Acknowledging the gravity of the situation, in 1992, the Forest Department with the active support of local Non-Governmental Organisations (NGO's) took a fresh and bold initiative. A plan for the rehabilitation of the degraded Girnar forest was worked out and new strategies were decided. The cornerstone of this strategy was to capture the imagination of people and link forest rehabilitation with their socio-economic well being. In this drought prone semi-arid region, where animal husbandry is a major occupation, it was not very difficult to identify two most important spin-offs from rejuvenation of the forest. The two products i.e. water and fodder (including grass) became major benefits, instead of a typical timber oriented approach, for any future forest recovery.

Because Asiatic Lions were found in Girnar forest until 1963, there was every possibility that the area might again become suitable habitat for lions. Moreover, in many aspects, such as forest type and vegetation, edapho-climatic conditions, terrain, rainfall, culture and ethos of local people, etc. Girnar and Gir are similar. All these factors made it possible to regenerate the area as a future home of the Asiatic Lion. Since in Gir, remarkable forest recovery occurred after implementation of the Gir Lion Sanctuary Project in the 70's, this approach seemed feasible at Girnar, except for concerns about people's response in the event of lions returning to the regenerated area. However, management of Girnar, being adjacent to the Junagadh City and having many religious places, has always been a very sensitive issue, because the number of stakeholders is high, diverse, enlightened and quite powerful. In managing and developing such an area, the interests of all sections of society must be integrated. The participation of everyone must be ensured for successful implementation and sustainability of the programme.

### **Staff training**

Staff were specifically asked to maintain a daily diary and record sightings of wild animals, killings, fire incidence, etc. In weekly meetings, all reports were then discussed. Highly participatory monthly meetings of staff and senior forest officials were held regularly, where a two-way exchange of ideas, problems and information, took place. Training and exposure through wildlife related films, visits from the doctor from the local Shakarbagh Asiatic Lion zoo etc. were regularly organised to increase the knowledge and information base of the staff. Relevant manuals and books related to forestry and wildlife management and technology were also made available to all staff. During this period, emphasis was also given to computerisation of records and development of a proper Management Information System (MIS).

To monitor wildlife, staff were also trained. In the case of lions, monitoring is easy because they are readily seen. In the case of panthers, recording of pug marks at water

points became the definitive source of information. Initially, pug marks were also recorded for ungulates but later, when populations grew, direct sightings became more frequent. People also started coming to these checkpoints (Thanas) in cases where wild boar, sambhar or blue bulls damaged their crops. Staff were also asked to report sightings of lions on the wireless network, so that higher officials could go to the locality of the sightings and confirm them. As per State policy, regular, highly transparent and participatory censuses are also held.

### **Integrated Watershed Development**

Thus, in the year 1992, well-planned efforts were made to not only reverse the process of degradation, but also to regenerate the highly degraded areas through integrated watershed development and improved habitat protection by enlisting the participation of local people. This programme was launched by forging effective partnerships between various stakeholders. Since the region falls into the semi-arid zone, and drought and scarcity is quite frequent and severe, people realised the importance of Gir and Girnar. These forests become the last refuges of a very large population of people and their livestock in the region, especially during severe droughts. After the severe droughts of 1987 and 1988, people understood the necessity of preserving their forests and started putting a higher value on conservation. They were also ready to contribute their efforts to the ongoing eco-restoration programme.

Whilst initiating the rehabilitation programme for the Girnar forest, top priority was given to effective communication and dialogue among the various stakeholders. As pointed out by the earlier report (SHARMA A. K. et al) on Girnar, staff working in Girnar and surrounding areas were highly demoralised and had lost the skills required to manage such a forest. First and foremost, effective communication was established among the staff and other forestry officials to ensure convergence towards a common goal. Various meetings, camps, discussions and training programmes were organised. To motivate staff and make them more focussed, lectures from successful people were also organised. It was ensured that officers and staff spent considerable time together in forests while patrolling, trekking, carrying out surveys, and implementing and monitoring various activities. All staff received training, especially to equip them for local planning, effective communication, execution and monitoring of work related to soil and moisture conservation, small masonry structures, raising planting stock of local species, raising plantations, silvicultural operations, fire control measures, wildlife monitoring and census etc. To achieve this, the help of well-trained, skilled people working in different fields was enlisted.

The demarcation exercise was implemented first, because in many places there was no clear-cut forest boundary. Since the forest is adjacent to the city and land values are high, people encroached onto forestland. After demarcation, many encroachers were removed. Similarly, the long standing problem of wood cutters (Kathiaras), numbering more than 1,000 who were entering the forests, cutting trees and bamboo and selling them in the local market was solved by creating alternative employment opportunities and strict enforcement of laws. Simultaneously, uncontrolled and rampant grazing was also controlled, and villagers and Maldharis (local graziers) were provided with the option of cutting grass and

taking it away free of cost. Dead, dry and wind-fallen wood and material available in naturally regenerated forest areas after silvicultural operations were made available to local people to meet their fuel-wood requirements. Controls on grazing, collection of dead and dying material and grass collection eliminated the problem of forest fire. Different afforestation works, carried out in the past under community forestry and other programmes, also improved availability of fuel-wood and small timber. A large number of biogas plants were also installed in peripheral villages to reduce dependence on fuel-wood.

Throughout Girnar, large-scale soil and moisture conservation (SMC) works were implemented as priorities. Since the terrain is undulating and hilly, intensive work was required. Staff prepared the Treatment Plan (work plan) of each area with the help of local villagers, volunteers, NGO's and officials from other technical departments. In this endeavour, traditional water conservation and harvesting technology used by the people of the region became very useful. SMC work was planned in such a manner that maximum water is harvested and ground water recharge takes place to the optimal possible extent. Check-dams were constructed on rivulets and all drainage lines were treated. While planning the programme, it has been the endeavour that watershed development works should be taken up in such a manner that maximum work is done manually and local people get continuous employment. Most of the works have involved nala bunding, gully plugging, digging of pits and contour trenches, nursery raising, planting, etc. However, major structures were also constructed, while carrying out the watershed development work in Girnar, to retain maximum water:

Table-IV : Details of major structures constructed

Year	No. of major structures constructed				
	Check dams	Vantalavadi (ponds)	Raised causeway	Retaining walls	Total
1992-93	2	6	-	-	8
1993-94	21	19	5	3	48
1994-95	21	10	-	18	49
1995-96	2	-	-	-	2
Total	46	35	5	21	107

Wherever necessary, planting of local fruit and fodder-yielding plants, was also undertaken. Predominantly, *Ailanthus excelsa*, *Holoptelia integrifolia*, *Acacia senegal*, *Mitragyana parvifolia*, *Dalbergia sisso*, *Ficus bengalensis*, *Azadirachta indica*, *Emblica officinalis*, *Acacia catechu*, *Pongammia pinnata*, *Gmelina arborea*, *Tectona grandis*, *Madhuca indica*, *Annona asuamosa*, *Sapindus emarginatus*, *Terminalia tomentosa*, *Butea monosperma*, *Acacia nilotica*, *Dendrocalamus strictus*, *Bamboosa arundanisia* etc. were planted. Keeping in view the soil moisture conditions of various sites and for developing specific habitat for various wild ungulates, following types (Table V) of plantation were taken up under different schemes in the Girnar:

Table V Areas regenerated with different kind of plantations

S. No.	Plantation type/ Name of the scheme	Area taken up for plantation (ha)						
		90-91	91-92	92-93	93-94	94-95	95-96	Total
1.	Soil & moisture conservation plantation	75	50	100	150	100	10	485
2.	Afforestation in degraded areas	-	50	50	75	50	50	275
3.	People's participation in the regeneration of degraded forest areas plantation	-	-	-	50	100	110	260
4.	Plantation for development of tourist places	-	-	12.5	-	-	-	12
5.	Minor forest produce plantation	10	10	6	15	7	5	53
6.	Fuel wood & Small timber plantation	50	50	6	35	20	15	176
7.	Irrigated plantation	5	5	5	10	-	-	25
8.	Medicinal plantation	15	15	10	-	-	-	40
9.	Urban resource plantation	-	25	15	-	15	-	55
10.	Rural resource plantation	-	25	15	25	15	-	80
11.	Area oriented fuel wood & fodder plantation	-	-	100	-	-	-	100
12. (a)	MFP including medicinal plantation	-	-	-	5	-	-	5
12. (b)	MFP (minor forest) plantation	-	-	-	5	30	5	40
Total		155	230	319.5	370	337	195	1606

Planting stock was raised in various decentralised nurseries. Seeds were collected from earmarked plus trees, selected on the basis of phenotype. Essentially, seeds from local forest trees were used. Except for teak, bamboo and grasses, seedlings were grown in polythene bags, of various sizes (10x10x15, 15x10x20 or 20x20x20 cm) depending on the duration for which seedlings were to be kept in the nursery and the sizes of the seedlings. In the field, pits were dug in such a manner to retain maximum moisture. Just after the first monsoon rain, planting was carried out in these pits and contour trenches. Post-planting care was carried out for three years including mulching, hoeing, weeding, watering and protection from fire and grazing. In planting areas and also other regenerating areas, other silvicultural operations like cutback and singling (especially in case of teak) was also done. Bamboo rhizomes, teak and local grasses were also planted on a large scale. Plantation operations are summarised in Table V.

## **Community Participation**

The whole work was carried out on a watershed basis. Due to well-planned, large-scale soil and moisture conservation works and control on grazing and fire, availability of grass and fodder increased manifold. Availability of non-timber forest products (NTFP's) increased so much that they started providing an alternate livelihood to people from neighbouring areas, which helped in maintaining peoples' interest. Their participation, therefore, increased. Since Girnar is the only source of water for Junagadh city and the neighbouring 39 villages, increased availability of water and reduced siltation in reservoirs ensured not only the wholehearted support of local people but also attracted them to participate in ongoing efforts. By carrying out watershed development work, areas bordering the forest became more productive because soil loss and floods stopped and the water table increased. Within two years, the water table rose and around the periphery, water availability increased. Since in this region, water is normally supplied by tankers for 8-9 months per year, benefits from watershed management in the upper hills and regenerated forest became very apparent and immediate.

While carrying out SMC work, priority was given to construction of check dams and developing permanent water holes for wildlife. Because the area is highly undulating, such structures became very useful for water storage. There were 3 major reservoirs in the forest area, which became perennial due to watershed management and improvement in vegetative cover. In fact many rivulets originating in the Girnar started flowing for a longer duration than in the past and now water remains available in many parts of the forest throughout the year. This, coupled with improvements in vegetation and effective protection, resulted in recovery of habitat and increase in the population of herbivores.

## **Nature Education**

Gujarat is a pioneer in the field of nature education especially in the form of Nature Education Camps, designed for school children, farmers, women, teachers and other special target groups. Since Girnar forest is very close to the city, it became much easier to develop many camping sites and treks to impart nature education and awareness to children. The Forest Department, with the help of local NGO's, schools, teachers, activists and a few very spirited scientists of Gujarat Agriculture University, started organising nature education camps. Due to the scale of SMC work, construction of check dams, nurseries, collection of NTFP's, grass, fodder, fuel-wood etc. staff and officials started staying in the forest areas and it became very difficult for anyone to indulge in illicit cutting and other illegal activities. Through the interest of local people and enlightened citizens, social monitoring started to take root.

## **Wildlife Monitoring**

For wildlife monitoring, watch-towers were constructed and continuous patrolling was undertaken in the form of various teams at different levels, thus improving overall

protection of the environment. After a proper survey, a highly effective wireless network was established throughout the forest. Every mobile and fixed station was named after a wild animal such as lion, panther, leopard, cheetal, sambhar, chinkara, blackbuck, rose (bluebull) etc. It brought a sense of belonging and staff felt proud that their station was named after wildlife. In fact, this started a race among staff for finding names of wildlife, as everyone wanted to be associated with wildlife. Despite very high wind velocity, a permanent wireless station was established at the highest peak of Girnar, which provided help to staff and officials in almost two-thirds of the state. All these wireless stations were manned continuously in shifts. This provided a sense of security among staff and allowed rapid detection of forest fires and reporting of lion sightings. All staff were provided with walkie-talkies and one-third of them were also given firearms. At these permanent wireless stations, all messages were recorded and regularly verified. This system became so effective that it was requested by the state level authorities to prepare a similar plan for the whole state, which was prepared and implemented immediately.

In the eco-restoration programme of Girnar, making water available to wildlife in association with forestry activities became paramount. In a forest area of 180 km<sup>2</sup>, 39 water sources were identified. Furthermore, by constructing check dams, percolation tanks, storage tanks, retaining walls etc., perennial water sources were created. By improved habitat protection, illicit liquor manufacturing was stopped, which freed more water sources for wildlife. Control of grazing by cattle improved the fodder availability to wild herbivores and since the area is highly suited for sambhar, their population grew rapidly. Overall improvement in protection eliminated poaching, and wildlife visibility improved. Because Girnar forest is a compact block, it became much easier to construct various checkpoints on the periphery of the forest. At 14 places, permanent check points with residential staff quarters and reasonable facilities were constructed. At all these checkpoints, permanent nurseries and water sources were created. This ensured that staff presence and monitoring of wildlife became much easier. At all these stations, a register to record wildlife sighting was kept. Similarly, local people were asked to inform staff at any of these nearest checkpoints, if any carnivore killed or attacked people or their cattle. All records of such incidences are maintained, as the Forest Department pays *ex-gratia* compensation to affected people.

#### IMPORTANT OBSERVATIONS

During the rainy season, migration of lions from Gir is quite common. They go quite far, sometimes up to 90 km and have been frequently seen on the periphery of Gir in peripheral grasslands (Vidis) and coastal plantations etc. In 1993, they also reached Girnar and after finding suitable habitat, stayed there. Most of the lions who came to Girnar were sub-adult males, except for one full-grown male. During 1993-94, no cubs were seen. However, in 1995 a female also appeared after the monsoon. It can be safely presumed that due to fighting for territory, the dominant male of the pride had thrown out the sub-adults. In 1996 (Bharat Lal), 6 cubs were reported in the Girnar and sightings became quite frequent. During this period, the sambhar population in Girnar grew rapidly and spotting these animals became very easy. In 1991 (A. K. Sharma) a group of spotted deer was observed

and photographed in the central portion of the Girnar forest. The wildlife census of 1995 showed that a large number of spotted deer are also present in the Girnar forest. The habitat of Girnar is best suited for sambhar. Due to plenty of fodder, water and security, bluebulls have also started to migrate in from nearby areas. In Girnar, leopards had always been present but after 1994, it appears that the leopard population also increased.

Due to increases in lion and leopard populations, killing of domestic animals also started to occur. On average, each lion kills about 9–10 domestic animals, mainly buffaloes, per year. The rest of the diet consists of wild ungulates. In Girnar, pride size varies from 1–4, but is mostly two or three. There is a fairly well developed system of recording killings, and a veterinary doctor examines each case and carries out a post-mortem so that compensation can be paid. In 1994, in a single night, two male lions killed seven buffalo in a nearby village on the periphery of the Girnar. Similarly, quite often, these lions sit on the roads or staircases leading to various temples in the forest and people ask for help from forest staff. Presence of lions and panthers reduced grazing and unauthorised entry of woodcutters, bootleggers, etc. especially during nights.

Table VI Distribution of the Asiatic Lion population (Lion Census, 1995)

S. No.	Area/ zone	Area (km <sup>2</sup> )	Asiatic Lion Population			
			Male	Female	Cubs	Total
1.	Gir National Park	258.7	10	12	9	31
2.	Gir Sanctuary	1,153.4	72	92	50	214
3.	Gir Peripheral forests	60.0	10	5	2	17
Sub-total in Gir			92	109	61	262
4.	Mitiyala forest	19.4	2	1	-	3
5.	Coastal zone	110.1	8	8	10	26
6.	Girnar forest	179.5	10	3	-	13
7.	Barda forest	192.3	-	-	-	-
Total			112	121	71	304

### Changes in forest cover

Gujarat is highly deficient in forest. Only 0.03 ha of forest is available per capita, compared with a national average of 0.7 ha. In the state, the recorded forest area is only 9.89%, compared with 23.28% for the whole country, whereas good forest covers only 6.4% of the total area, compared with a national average of 19.27%. However, community forestry, started in the 1970's has taken deep roots in the state. In fact, social forestry and coastal border plantations, to reduce the impact of sand-laden wind on inland farms, have given immense economic benefits to local people. Gujarat has a very long coastline measuring 1,600 km and ingress of salinity has been prevented to a large extent by establishment large-scale plantations on coastal land. In addition, due to influence of religion and culture, protection of wild animals is in the ethos of the people.

The Forest Survey of India regularly monitors changes in forest cover using satellite images, followed by verification by ground-truthing. According to the State of the Forest

Reports, published in 1993, 1995 and 1997, in Junagadh district, 139 km<sup>2</sup> of open forest (density less than 40%) was converted into dense forest (density 40% and above). In contrast, over the rest of the country, during the same period, forest cover hardly improved (see Table VII).

Table VII Comparative changes in forest cover

Name of the district/ State/ Country	Change in forest cover (In sq km)			
	1991	1993	1995	1997
Junagadh district (open to dense forest)	-	+35	+104	-
Gujarat State (including mangroves)	-14	+137	+276	+258
India (all)	+560	+22	-507	-5,482

According to the State of the Forest Report (1995), in Junagadh district 104 km<sup>2</sup> of open forest (density 10-40%) was converted into dense forest (density >40%), whereas in rest of the country, during the corresponding period, only 76 km<sup>2</sup> of open forest was converted into dense forest. Furthermore, in Gujarat there was an increase of 270 km<sup>2</sup> of mangrove forest, whereas in the rest of the country, only a 7-km<sup>2</sup> area was added to mangrove forests during the corresponding period. Similarly, the State of the Forest Report of 1997 revealed that there was a further increase of 302 km<sup>2</sup> of mangrove forest, whereas the figure for whole of the whole country was only 294 km<sup>2</sup>. This means that in other areas of the country, mangrove forest is still being lost.

Currently, forest cover in Girnar has increased. Degraded, open rain-shadow areas have regenerated. Due to increased moisture and retention of soil, regeneration is very good. All natural species have regenerated. Since, at present, the Forest Survey of India monitors change in forest cover using satellite images at the macro-level above 40% density, all forests are grouped together, so a new study (GEER Foundation) was implemented to determine block-wise changes in forest cover of Girnar. That study (1998) compared forest cover in 1986 with that in and 1997. Details of the satellite data used are given in below (Table VIII).

Table VIII Details of satellite data used

Satellite	Path	Row	Product	Date
LAND SAT	150	45	TM FCC	November 23, 1986
IRS – IC	91	57	LISS-III FCC	November 01, 1997

For this study, changes in forest cover were classified as per the Forest Survey of India classification. According to that classification, forests are termed as dense forest (density more than 40%), open forest (density 30-40%), degraded forest (density 10-30%) and highly degraded forest (density less than 10%). Analysis of satellite data showed dramatic changes in dense forest cover of Girnar between 1986 and 1997 (Table IX). In 1997, 73.6% of the Girnar forest could be classified as dense, whereas in 1986, dense forest covered only 31.6% of the area. On the other hand, during the same period, open, degraded or highly degraded forest was reduced from 66.9% in 1986 to 25.0% in 1997. One of the most interesting

changes, apart from the change in dense forest cover, is a more than four times increase in water bodies. Although in 1997 rainfall was good, nevertheless watershed development in Girnar resulted in reduced run-off, revived rivulets and longer retention of water, which helped in solving water problems in the region.

Table IX Changes in forest cover of Girnar

S. No.	Category	1986		1997	
		Area (ha)	% of the total area	Area (ha)	% of the total area
1.	Dense forest	5,684.3	31.6	13,222.3	73.6
2.	Open forest	5,050.6	28.0	2,521.3	14.0
3.	Degraded forest	4,414.3	24.5	1,606.0	8.9
4.	Highly degraded forest	2,602.7	14.4	393.0	2.1
5.	Cultivation	-	-	-	-
6.	Blank	160.7	0.8	87.4	0.4
7.	Water bodies	25.0	-	105.9	0.5
8.	Settlement villages	17.0	-	18.7	-
Total		17,954.6	100%	17,954.6	100%

Due to large-scale watershed development work, the microclimate inside Girnar has changed. Due to increased moisture and reduced temperatures, the whole area has naturally regenerated with minimal planting and most of the wildlife, originally present, has returned. The Rusty Spotted Cat has probably colonised the Girnar. This species is normally found in the moist deciduous/evergreen forest of the Western Ghats. In 1996, an abandoned cub was captured in the Girnar forest, illustrating the change in the microclimate of the Girnar, due to SMC work and regeneration of natural species.

## CONCLUSION

In India, like in many other countries, current policy is to manage forests sustainably, whilst accommodating cross-sectoral interests. Eco-restoration of Girnar Forest in Junagadh has given new hope of reversing degradation and restoring the area to its original condition. Forest restoration has shown that wildlife habitat can also be increased, provided a strong will is there. In Gujarat, this has been further strengthened after 1996, when throughout the state, such work has been taken up on a large scale under the OECF-Japan aided Integrated Forestry Development Project (IFDP). In fact, increases in forest cover due to coastal plantations and mangroves have given further impetus to ongoing efforts. The success of Girnar provides a solution to the problem of finding suitable habitat for the growing population of Asiatic Lions. It seems that the lion population in Gir forest may have reached its carrying capacity, because dispersal is frequent. The fact that lions migrate to and settled in Girnar, demonstrates that lion habitat can be increased and suitable management policies can be adopted. Based on the Lion Census of 1995, during preparation of the Management Plan of Gir PA, we mooted the idea to form a **Greater Gir Ecosystem**, comprising peripheral grasslands, coastal plantations, Mitiyala, Barda and Girnar forests. Once the

concept of the Greater Gir Ecosystem is adopted, the home of Asiatic Lion will be increased from the present area of 1,4121 km<sup>2</sup> to 1,973.4 km<sup>2</sup> (Table VI). This additional 560.3 km<sup>2</sup> will accommodate these lions with a proper prey base and also reduce threats to this species.

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## QUESTIONS AND COMMENTS

### ***Anders Pedersen***

This work has the narrow aim of creating habitat for a single species, in contrast with the approach of Nigel Tucker, which tries to create ecosystems for a broad range of species.

As far as I know the lion likes open grassland for hunting, as its prey mainly live in such habitat, but the panther prefers dense forest. How do you reconcile these different needs?

***Bharat Lal***

Yes, lions prefer open forest, but in Gir, there is no typically open grassland, it's more like scrub. In the Girnar area, the forest had become so dense that some kind of thinning is required. However, such thinning might set a bad example. In the state, panthers kill few people each year. We have to combine many factors, including socio-economic in the restoration of such areas. In the forest, we try to have some more open areas too for lions.

***John Parrotta***

This seems to be an exceptional success story, set against extreme local hardship and degradation. It overcomes socio-economic problems and carries out good restoration, whilst harnessing human resources within a multi-agency organisation. It also involves the local community. The key to gaining such large support is the focus on water. The subject of water has arisen repeatedly in this discussions and presentations during this workshop<sup>2</sup>. Deforestation disrupts hydrological cycles and depletes both rural and urban water supplies. By stressing the issue of water resources, project directors can be persuaded to use intensive restoration techniques, particularly on heavily degraded sites, such as mines. I wonder if this work has been repeated in other national parks in India? Are similar projects being implemented to conserve elephants or tigers?

***Bharat Lal***

Project Elephant and Project Tiger launched by the Government of India are very famous. Project Tiger increased the tiger population in the last 25 years from about 1,200 to 4,000. The number of elephants have also increased. Poaching is still a problem for tigers, but fortunately not for lions. There are also problems of tigers killing domestic animals and elephants causing crop damage. One factor has been the liberal conservation programmes of the government with generous funding. Funds are transferred to local governments and also to local communities and committees for watershed management.

***Abdur Rashid***

What methods were used to census the lions after the restoration in 1993?

***Bharat Lal***

The census was made by direct sightings. Water and prey were provided to attract the lions for counting at different stations all over the park. In Girnar forest the last lion was seen in 1963. In the 1974 census only 1 pair was recorded. In the 1995 census, 10 males and 3 females were seen but only 1 male was fully-grown. In 1996, 6 cubs were observed with 3 more this year.

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<sup>2</sup> Editor's note: this resulted in research proposal 5.2, outlined in Part 7.