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THE ASIATIC LION (*PANTHERA LEO PERSICA*): 50 YEARS JOURNEY FOR CONSERVATION OF AN ENDANGERED CARNIVORE AND ITS HABITAT IN GIR PROTECTED AREA, GUJARAT, INDIA

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ABSTRACT

Asiatic lion (*Panthera leo persica)* is a flagship species of the semi-arid dry deciduous forest tracts of Gujarat in Saurashtra. The species was critically endangered and the numbers had drastically reduced from its historic range due to loss of habitat and hunting. A ban on hunting was enforced in the last remnant pocket of their territory, the Gir forests by the erstwhile Nawab of Junagadh. Post-independence, due to the persistent efforts of the State Forest Department with the continuous support of local people, the population has been rescued from the brink of extinction and now the number has reached to 523 in 2015. Because of this the species has been upgraded to Endangered Category of the IUCN. This poses a globally acclaimed conservation success story of a large carnivore. The lion population once confined to about 1800 km^2 of Gir forest area now occupies an area of 7000 km^2 and is distributed in about 12000 km^2 area of Saurashtra region, Greater Gir landscape of Gujarat, thus reclaiming its lost territory. This paper discusses the various measures and actions that were taken to ensure that this unique species could be conserved in its native range and to ensure long term conservation in a dynamic habitat.

Key words: Asiatic lion, Protected area, Gir forest, Greater Gir landscape, Endangered.

Introduction

Globally, 8 sub species of lions have been recognised on the basis of external characteristic features, their manes and distribution in African and Asian Continents. The sub species have been named as Barbary Lion (*Panthera leo leo*) of Northern Africa, extinct in wild (Nowell and Jackson, 1996; Black *et al*., 2013), West African Lion (*Panthera leo senegalensis*) found in Western and Central Africa (MacDonald, 2006; Sunquist and Sunquist, 2009), Masai Lion (*Panthera leo nubica*) found in Eastern Africa (MacDonald, 2006), Congo Lion *(Panthera leo azandica*) of Central Africa (Sunquist and Sunquist, 2009), South-West African Lion *(*Panthera *leo bleyenbberghi*) of South-West Africa (MacDonald, 2006), Transvaal Lion (*Panthra leo krugeri*) of Southern Africa (MacDonald, 2006), Ethiopian Lion (*Panthera leo roosevelti*) of North Eastern Africa (Bruche *et al*., 2012) and Asiatic Lion (*Panthera leo persica*) found in Gir forests of Gujarat (Singh and Gibson, 2011). The research work on all the 8 sub species revealed the existence of only 3 sub species on the basis of Mitochondrial DNA as African sub population; West, Central and North African Lions (*Panthera leo leo*), South and East African Lions (*Panthera leo melanochita*) and Asiatic sub population of West India-Gujarat (*Panthera leo persica*) (Bauer *et al*., 2016).

Conservation of Asiatic lions (*Panthera leo persica*) illustrates a global success story and showcases commitments and efficacies of India's conservation governances in protecting an endangered large carnivore (Divyabhanusinh, 2005; Singh and Gibson, 2011). Asiatic lions that once ranged from Persia to Palamau in eastern India were almost driven to extinction by indiscriminate hunting and habitat loss (Joslin, 1973). A single population of less than 50 lions persisted in the Gir forests of Gujarat by late 1890's (Divyabhanusinh, 2005). With timely and stringent protection offered by the Nawabs of Junagadh and subsequently by Gujarat State-run Forest Department, Gir lions have increased to the current population of over 500 (Gujarat Forest Department, 2015). Lions were restricted to the Protected Area of Gir (1,800 km^2) till the late 1980's, but have since dispersed in large tracts of human-dominated agro-pastoral landscapes of Saurashtra peninsula.

Study area

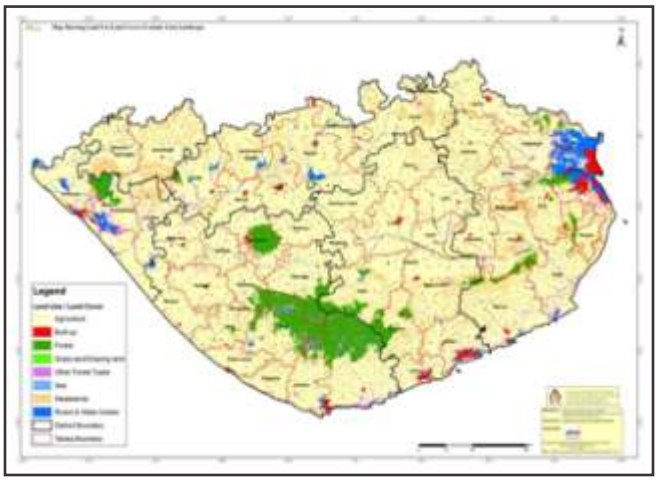
Gir Forest of Saurashtra Peninsula of Gujarat in India is globally known for being the last refuge for the Asiatic lions. Gir forest, situated between latitude 20^0 40' to 21^0 50' N and longitude 70^0 50' to 71^0 15' E, was formerly the hunting grounds of the erstwhile Nawab of Junagadh. Presently, this is the largest intact and continuous tract in peninsula unique in its rich floral and faunal diversity and the origin of seven important rivers. The forest is a lifeline of people of southern Saurashtra for drinking water and irrigation. The total area of Gir Sanctuary and National

Journey of Asiatic lion, biodiversity and landscape conservation in Gujarat state is highlighted.

Park extends to 1413.13 km^2 of which 258.71 km^2 core area is the National Park and surrounding 1153.42 km^2 area is the Wildlife Sanctuary. Other Protected Areas namely Paniya Sanctuary of 39.64 km^2 and Mitiyala Sanctuary of 18.22 km^2 are the integral part of Gir Protected Area. 227.90 km^2 Reserved forests, 107.51 km^2 of Protected forests and 77.63 km^2 Unclassed forest surrounding to the Gir are the buffer areas, making 1883.04 km^2 of Gir Protected Area Network of Junagadh, Gir-Somnath and Amreli districts of Saurashtra peninsula managed by Wildlife Circle, Junagadh.

Distribution of asiatic lions

Once Asiatic lions were widely distributed in Asia covering Mesopotamia, Persia and the Indian subcontinent and found in abundance upto the end of the 19th century (Joslin, 1973). Gradual habitat loss and over-hunting lead to their extirpation. The last lion surviving outside the Saurashtra was reported in 1884 (Seshadri, 1969). In Saurashtra, lions occupied areas in Dhrangdhara, parts of Jasdan, Chotila, Alech hills, Barda hills, Girnar and the Gir forest. By the onset of 20th century, the population got fragmented and ultimately restricted to the Gir forest only. The numbers of lions in Gir forest remained less than 50 in 1880 and reached the very brink of extinction. Due to timely protection and stringent measures taken by the Nawab of Junagadh the lion population recovered before India got independence. After independence, Gujarat state was formed on first May, 1960 and the state enacted "The Gujarat Wild Animals and Wild Birds Protection Act, 1963" and Gir Sanctuary was declared and notified on 18/09/1965 under the provisions of this Act. After declaration of the Sanctuary, the population of lions was estimated to be 177 in the year 1968 (Dalvi, 1969). The sanctuary entered in its 50th year on 18/09/2015 and Golden Jubilee year was celebrated during the year 2015-16 and deliberated about the milestones achieved and appreciated the efforts made by Forest Managers with the help of local people and the stakeholders. The journey of 50 years of the Sanctuary Management has been discussed in this paper.



Journey of conservation

From 1935 to 1952, the dry deciduous forest of Gir was worked with simple coppice system i.e. clear felling with reservation of fruit trees e.g. Rayan (*Manilkara hexendra*), Ambo (*Mangifera indica*), Khati Amli (*Tamarindus indica*), Aritha (*Sapindus laurifolius*), etc. As per Acharya's Plan, the forests were worked by the prescriptions of superior and inferior teak working circles but focus shifted from forest working to wildlife management after declaration of Gir Wildlife Sanctuary in 1965. The management of Gir Protected Area during its Golden Jubilee Period (1965-2015) is discussed, dividing into five decades with its themes of development.

Decade 1 (1965-1975): Shift to wildlife conservation

Year 1966 to 1970: The Gir forest worked as per Acharya Plan from 1956-72 but emphasis shifted towards the conservation of wildlife from 1965 onwards. The Asiatic Lion Population Estimation was carried out in 1968 after the declaration of the Gir Sanctuary, using visual counts through baiting and 177 lions were recorded (Dalvi, 1969). By pugmark technique, a total of 166 lions were estimated which was improved to 177 lions by direct sighting method on the live baits. First time, it was decided to adopt the direct visual count method which would ensure greater accuracy. The counting was completed between 27/05/1968 to 04/06/1968. Taking the advantage of community feeding of lions and use of baits to congregate lions for visitors, the bait system was introduced for counting the lions. The census area was divided into three zones, nine sub zones and 41 blocks. Each zone was in charge of a forest officer in the rank of Deputy Conservator of Forests (DCF). Wild ungulates and major carnivores were counted on water holes in May when full moon night was in middle of the census so that animals could be identified at the water holes at night. A total of 5500 ungulates were also counted at water holes. In this census, the visual counting and the pugmark technique were compared to get the results. During this counting, 17% of the total lion population was located outside the Gir forests but the animal was not found in the Girnar range or in the Mitiyala forests in this census. The Wildlife Division at Sasan was created in 1967 to carry out research and conservation activity of the Asiatic Lions. Consequently, the Gir Ecological Research Station was established at Sasan in 1969. The Wildlife Circle, Junagadh was created in 1970 to manage the Gir Forest with focus to conserve Asiatic Lion and other wildlife. From the period 1965-66 to

1973-74, an area of 500 ha was planted along the coastal border of Gujarat adjoining Gir Protected Area. A total length of 301.4 km. forest area was demarcated of Gir Wildlife Division during the period 1961-62 to 1968-69. Paul Joslin of University of Edinburgh began his three-year Ph.D. fieldwork at Gir Wildlife sanctuary in 1968 on the Ecology of Asiatic Lions. The salient findings of his research work were that it was not true that the Asiatic lion population was declining due to poisoning of lions rather it was the effect of habitat manipulation due to green revolution upon the lions, due to low population of ungulates (5000-6000) inside the sanctuary, lions used to move out of the sanctuary in search of food and to feed upon the livestock. However, it was found that the lions were not able to cherish their hunt fully because the hide collectors and vultures would take away their hunt. Also, in 1971, right before Joslin left Gir, he made few provisions that could indicate the lion abundance in Gir; one was through tracking of lions by observing lion's pugmarks on the road and second was through scat analysis on both daily and weekly basis (Joslin, 1973).

Year 1971 to 1975: The Gir Lion Sanctuary Project was launched in 1972. The ambitious scheme of development of Gir sanctuary with an estimated cost of `44.60 lakhs was implemented from 1971-72 till 1975-76. The scheme aimed at shifting all resident Maldharis outside the sanctuary, demarcating the sanctuary boundaries and preparing peripheral roads and firelines in the sanctuary area. The Gir Wildlife Division was bifurcated into Gir West and East Divisions in 1972. The second Asiatic Lion population estimation was carried out in 1974 and counted 180 lions (2% growth from previous estimate). The Asiatic Lion census is conducted every five years but this census was delayed by one year due to the acute scarcity conditions that prevailed in the year. For organizing census, the entire area was divided into 8 zones, and 23 sub zones. Ungulates and major carnivores were counted on the water holes during a period in May on the full moon night. The pugmarks were also traced and counted, but finally the lions were counted accurately on the live baits of buffaloes and goats at 75 locations, although 104 sites were selected initially for bait counting. Also, 436 points were fixed for carrying out the census of the animal on water holes. The goats were also employed in this operation as bleating of the animal could be heard from a long distance to attract lions. During the count on live baits, attempts were made to colour the lions which came on the baits. Throwing of dye filled rubber balloons was tried at all the centres, but only 40 lions could be successfully coloured. Marking the lions with dye reduced the double counting of the same lion. A total of 155 leopards, 71 hyena, 9900 ungulates and 3950 langur monkeys were also counted. One hundred and ninety Maldhari families out of the decided 845 families were shifted between 1972 and 1976 and were resettled with the implementation of Maldhari Resettlement Scheme. 1503.40 ha. Forest Land and 1541.42 ha. Revenue land was allotted for the scheme. The Gir Sanctuary was awarded the Challenge Trophy by the Chairman, Indian Board of Wildlife for being the best managed Sanctuary in the country for the year 1975-76. An area of 140.40 km^2. forest in Jamvala and Chhodavadi Ranges of Gir Wildlife Sanctuary was constituted as National Park vide notification No.AKH/167/WLP/20174/22133-P dated 21/05/1975. A study on status of Crocodiles in Kamleshvar was carried out and 20 Crocodiles were spotted in 1975 (Joseph *et al.,* 1975). Considering the unstable, unnatural and unfavourable conditions of lions at Gir forest the study of "herbivory (dynamics of plant consumption by selected herbivores) and predation of the wild ungulates of Gir" by Stephen Berwick from Yale University during early 1970s, aimed to propose some strategies to conserve lion and other biota of Gir. The results of the study were actually myth breakers, the popular assumption that livestock are restricting the number the wild ungulates inside Gir through forage competition was broken through the data collected. During the research, ecology of 5 major wild ungulates was studied, namely, Chital, Nilgai, Chinkara, Sambar and Four-horned antelope. Results on feeding habits showed that wild ungulates were rather sharing the same food sources and were not facing competition from the livestock. However, overgrazing due to overstocking was found to cause decline in the plant productivity and hence, a long-term effect of reduced productivity on wild ungulates was feared. Total annual biomass turnover of prey biomass calculated was 128,859 kg/year as compared to that of 129,189 kg/year required by lions and leopards. So, the low population of wild ungulates was rather seen as the result of kills made by lions and leopards and forage competition by livestock. Therefore, it was concluded that removal of livestock from the Gir forest would only further increase the pressure on wild ungulates (as lion and leopard kill would increase).

Decade 2 (1975-1985): Habitat Conservation

Year 1976 to 1980: The management of Gir forests, conducted as per Joshi's Plan (1976 to 1985) after the revision of Acharya Plan, completely changed the traditional approach of working of forests to Wildlife management on the concept of biodiversity conservation and improvement of habitat. The key thrust areas focussed in Joshi's working plan (1976) were conservation and improvement of wildlife and its habitat. The plan

aimed to minimize the human interference and remove the ecological imbalance along with improvising of the aesthetic and recreational value of tourism and meeting with the local demands of forest produce. The plan emphasized the initiation of research and education in wildlife management. Aiming at establishing harmony between local people and the wildlife managers, the Nature Education concept was conceived and camps were started in 1976. To improve the habitat, 7048 ha area was afforested from 1976-77 to 1979-80 and the emphasis was given to plantation of Teak, Khair and Bamboo. An area of 118.31 km^2 was added to Gir National Park vide notification No. AKH/97-78:A/WLP/2070/89387 dated 12/07/1978 thereby increasing its total present area to 258.71 km^2. (Core area). The Barda Wildlife Sanctuary comprising an area of 192.31 km^2 in Jamnagar and Porbandar districts of Gujarat was notified in 1979 and the area was identified as a second home for the Asiatic Lion. The Crocodile Breeding Centre was established at Sasan in 1978-79 under the aegis of the National Crocodile Conservation Project. Lion population estimation was carried out in 1979 and recorded 205 lions (14% growth from previous estimate). The technique of the wild animal counting of 1968 was repeated in this census also. The major wild mammals, including lions were counted on the water holes. Finally, lions were counted accurately on baits as was done in the previous census. 161 leopards, 84 hyenas, 14960 ungulates and 7000 langur monkeys were also counted.

Year 1981 to 1985: The Gir Nature Orientation Centre was established in 1981. A total of about 2.81 million trees were uprooted during the cyclone that occurred in 1982. The extraction and removal of uprooted trees was taken on priority. The habitat improvement and developmental works were carried out to bridge the gap due to the loss of vegetation by the cyclone. Plantation of browsable species in 350 ha. area was undertaken between 1977-79 and 1984-85. Lion population estimation was carried out in 1985 and recorded 239 lions (17% growth from previous estimate). The counting due in 1984 was postponed by one year due to a cyclone in November 1982 that created devastating condition in Gir. Wild animals, including lions were counted in 1985 at 487 water holes. Finally, lions were counted separately on baits at about 90 locations. A total of 201 leopards, 192 hyena, 16910 ungulates were also counted. Gir Maldharis continued to be resettled, by 1986-87 a total of 592 Maldhari families had been resettled.

Decade 3 (1985-1995): Forest restoration

Year 1986 to 1990: The scheme of Drought Prone Area Programme (DPAP) was reinitiated in 1986-87 to 1994-95 and 384.1 ha. area had been worked by SMC works, rubble wall fencing, grass improvement works and afforestation. Medicinal plants were planted in 70 ha area during 1986-87 to 1992-93. For salinity ingress control, 783 ha. area was planted in Gir forests between 1989-90 and 1992-93. As the population of the lions was on continuous increase, the Gir forest area was extended by notifying an area of 39.64 km^2 as Paniya Wildlife Sanctuary in 1989. Lion population estimation was carried out in 1990 and recorded 284 lions (19% growth from previous estimate). The lions were counted on 59 live bait locations. In this census, 17 lions were recorded outside Gir and its surrounding areas. A total of 212 leopards, 97 hyenas and 32790 ungulates were also counted at water holes. Stringent protection measures against tree cutting and poaching were undertaken.

Year 1991 to 1995: A scheme for rehabilitation of degraded forest was implemented under the project aided by the World Bank. 440 ha area of social forestry divisions of Junagadh and Amreli were afforested during 1991-92 to 1994-95. The Eco-development scheme was started in 1992-93 in the periphery of the Gir forest. Works like construction of check dams, removal of invasive species like *Lantana*, gully plugging, pasture development, construction of biogas plant, immunization of livestock, distribution of horticultural plants, treatment camps and exposure visits of Maldharis for environmental awareness were carried out. An area of 140 ha was covered by plantation of Minor Forest Produce during 1993-94 to 1994-95. The Lion population was estimated in 1995 by bait count method and recorded 304 lions (7% growth from previous estimate).Wild ungulates, including lions were counted at 651 water holes in the month of May. Finally, lions were counted accurately on 94 live baits. About 250 live baits were used in this operation. The population of the lion remained almost at the same level in the Gir forests but the number increased to 42 lions which stayed outside the Gir forests and surrounding areas. A total of 268 leopards, 137 hyenas, 38220 ungulates were also counted. The area was divided into 3 regions, 17 zones, and 67 subzones. About 700 staff members and about 1100 labourers were employed for the job. The water hole counting of ungulates was rationalized after comparing the result of the road count method. The developments of forest outside Gir and community awareness programmes were initiated owing to the movement of lions outside the Gir Protected Area. After the establishment of Wildlife Institute of India (WII) in 1986, among many other PAs in India, Gir found a nodal position in WII's mandate. The first phase of this research happened after successful phasing out of Maldharis from

inside the PA to outside (as per recommendations from Berwick and Joslin) by the Gujarat Forest Department. Half a dozen of the lions were put with radio-transmitters which allowed scientists and researchers to gain insights into their ranging patterns and behaviour. Results yielded that females have almost half the home ranges (60 km^2) of territorial males. Also, information regarding lion predation pattern and diet was characterized from radio-tracking and scat analysis. A quantum-shift in diet of lions were seen. Previously lions were found to feed mostly (65% of their diet) on domestic livestock of the Maldharis (Joslin 1973).

Decade 4 (1995-2005): Biodiversity conservation

Year 1996 to 2000: The Gir forests were managed from 1996-2006 as per the Biodiversity Conservation Plan for Gir designed by Singh and Kamboj (1996). The overall mission of the plan was to protect and conserve the Gir ecosystem and its rich biodiversity. The objectives proposed in the said plan were to protect and conserve the Gir ecosystem in a manner that is consistent with the ultimate and perpetual conservation of Asiatic lion and all other life forms and systems that together constitute the ecosystem, to improve the health of the forest their ecological functions and productivity including fodder, firewood, small timber and other forest produce, to their optimum level in consonance and consistent with the first objective, to elicit peoples participation in the biodiversity conservation through imparting nature education and promoting wildlife tourism, to reduce negative impacts on biodiversity through appropriate eco-development programme and to promote ecological studies and ecological research in pursuance of the above objectives. The India Eco-development Project was implemented from 1996 to 2001 and over 140 Eco-Development Committees (EDCs) were constituted in and around Gir Wildlife Sanctuary to carry out the eco-developmental works in these areas. The concept of management of the Greater Gir was conceived in the plan. As per the prescription of the plan, Girnar and Mitiyala were eventually declared as Sanctuaries. After the initial phase of research on lions and their habitat by WII which yielded two Ph.D. theses, the question still loomed over how to individually identify lions and count them in a robust manner, as lions lack the necessary identifiable marks like tiger-stripes or leopard-spots. However, the technique developed for African lions by Pennycuick and Rudnai (1970) by using vibrissae patterns were tried on Asiatic lions. Dr. Y.V. Jhala and his team developed a new technique by adding new fields to Pennycuick and Rudnai's (1970) whisker technique, such as new countable rows of the whiskers, permanent scars and ear-marks (Jhala *et al*., 1999). Thus a new scientifically tested technique for identifying individual Asiatic lions was developed.

Year 2001 to 2005: A supplementary management plan was prepared by Pathak (2002) and the works were carried out as per the plan till 2006. This plan attempted to retain all the good management practices of the previous management plan and propose needs with additions and alterations. It also attempted to shift emphasis on priority threats, particularly the threat of losing wildlife habitat through encroachment. The plan holistically tried to address the management of the protected areas in the Greater Gir region. The lion population estimation was carried out in 2001- Lion population doubled since 1968, with an estimate of 327 individuals (8% growth from previous estimate). The use of baits for lion population estimation was stopped as a result of a public interest litigation in the Gujarat High Court in 2001 and lions were counted by beat count and water hole count i.e. direct counting methods. The lion counting was planned in 2000 but was postponed due to the heavy rains on the previous day of the census operation. An internal survey by the forest department had reported a population of about 310 to 320 lions. In May 2001, the lions were counted at water holes, which were later corrected by the beat counting by the staff. A total of 271 lions were counted in Gir, 13 in Girnar, 20 in coastal areas, 16 in Mitiyala and Hippavadli zone and 7 in the villages near the Gir West. At the same time, a total of 53600 ungulates were also counted. The Asiatic Lions spread in areas outside Gir National Park and Wildlife Sanctuary to Girnar, Paniya and Mitiyala Wildlife Sanctuaries. Mitiyala Wildlife Sanctuary comprising an area of 18.22 km^2 was also notified in 2004 as a part of the Gir Protected Area Network. Asiatic lion population estimation was conducted in 2005 and recorded 359 lions (10% growth from previous estimate). This census was conducted from 21/04/2005 to 26/04/2005. Like in the previous census in 2001, baits were not used and a direct counting method, named beat counting, was used as a beat was the smallest unit for counting lions. On the basis of lion's kill or direct sighting, the lion was reported in 26 talukas in four districts (Junagadh, Bhesan, Visavadar, Mendarda, Malia, Talala, Veraval, Keshod, Vanthali, Manavadar in Junagadh, Amreli, Dhari, Khambha, Rajula, Jafrabad, Liliya and Savarkundla in Amreli, Gariyadhar, Palitana and Mahua in Bhavnagar and Porbandar, Kutiyana and Ranavav talukas in Porbandar). The entire area was divided into six regions against three regions in the previous census, each under the charge of an officer in the rank of Conservator of Forests. The regions were divided into 26 zones, 90 subzones, and 286 beats/village counting areas. Compared to the previous three censuses, lion

number in the Gir Protected Area and its peripheral forests and villages increased to 291. Among the satellite areas, 17 lions were counted in Girnar, 12 in coastal forests of Una, Kodinar, and Sutrapada and 39 in Mitiyala sanctuary, forest patches in Liliya, and fringe area of upper submergence of Shetrunji dam, Hippavadli zone, and other such areas in Bhavnagar. Of this, 17 lions were counted in Bhavnagar, 8 in Mitiyala and the rest in Liliya-Dholikui area. Number of the lion in and around Gir was about 270, during the last three censuses from 1990 to 2001 but it increased by about 20 individuals. Based on the analysis of the census data, it was understood that the carrying capacity of the Gir forest is about 270 lions. In fact the carrying capacity of the big cats is judged by the number of adults because the cubs do not play competitive role in the habitat. In 1995 and 2001, the numbers of the cubs and sub adult were 110 and 112 respectively, but in 2005, this number was 146. Practically, the number of adult and sub adult lions remained at the same level of about 210-220 animals during the last four censuses within the Gir boundaries. A total of 51330 wild ungulates (about 41080 spotted deer, 3770 sambars, 1020 bluebulls, 500 chinkara, 680 four horned antelope, 3280 wild boars) were estimated. Department of Wildlife Sciences, Aligarh Muslim University in collaboration with Gujarat forest department implemented two projects from 2002-2011 in Gir namely Leopard ecology project and hyena ecology project. Leopard project is an ongoing project of which phase two has been completed and third phase is going on while hyena ecology project was completed in 2010. Data pertaining to prey availability, food habits, predation, habitat use and home range of leopards was assessed in the western part of the sanctuary. Distance sampling, scat analysis, kill searches, sign surveys and radio collaring was used in order to achieve the results. It was found that most abundant prey of leopard was chital followed by peafowl and langur. Food habit analysis revealed that leopard's diet was diverse and dominant with two deer species namely chital and sambar. Predation results also reveal dominancy of chital in the diet of leopards and kleptoparasitism of leopard's kills by lions was also evident during the kill searches. Dense forest was used maximum by leopards for resting as well as the killing and consumption sites. A total of 4 male individuals and one female individual in human dominated landscape around Gir were radio collared during this phase. All individuals seem to maintain small home ranges and used diverse habitat in their range. Female leopard was found to live in close proximity of humans and used farmlands as major habitat (Khan *et al.,* 2004). With the results from the first 10 years of study being communicated to the Gujarat Forest Department, a need for developing a scientific continuous monitoring scheme for Gir was proposed so as to enable the managers to keep check on the pulse of Gir ecosystem. The Wildlife Institute of India was bestowed with this job and scientists and researchers started developing full-fledged monitoring protocol for Gir with lions at the nodal centre but covering aspects of prey, habitat, co-predators and human-interface. 6 more lions were fitted with transmitters and they spanned across the 3 eco-regions of Gir, western WLS, central NP and Eastern WLS. Permanent foot transects were laid for enumerating wild ungulate numbers, vehicle transects were done for corroborating the same. During WII study, data from radio-locations and continuous behavioural observations from collared lion individuals suggested that lions were quite catholic in their habitat choice with a preference ladder of Moist Mixed forests>Mixed forests>Savanna habitats>Teak-Acacia-Zizyphus-Anogeissus forests>Acacia-Lannea Boswellia forests>Thorn and Scrub forests>Agriculture areas (Jhala *et al*., 2009). Transmitters were fitted onto male coalitions inside the PA and through behavioural observations; a peek into male lion social organization was made. Asiatic male lions differed from their African counterparts in living their lives differently from the female prides. Also, activity patterns and territory acquisition behaviour were documented and analyzed (Meena, 2008).

Decade 5 (2005-2015): Landscape conservation

Year 2006 to 2010: The management of the Gir forests was carried out as per the Supplementary Management Plan for Gir by Pathak in 2006, the plan focused on Wildlife Protection and Eco-Development activities. The unfortunate incidences of poaching of 7 lions occurred in 2007, the offenders were identified, arrested and convicted in the court of law. In order to strengthen conservation efforts and ensure long term safety of the wildlife of the area, the Gujarat State Lion Conservation Society (GSLCS) was constituted in 2007 and a new Task Force Division was set up in 2008. Modern technology was provided with more infrastructure and facilities to forest staff. Construction of parapet walls around open wells started in 2007-08 and over 17000 wells have been protected around 300 villages of Gir PA Network. The Girnar Wildlife Sanctuary comprising an area of 181 sq. km. was notified in 2008. The Asiatic Lion Gene Pool conservation project was initiated. The Lion population estimation in 2010 recorded 411 lions (15% growth from previous estimate). The census was conducted between 24/04/2010 to 27/04/2010. The counting was done through beat verification cum pugmark method. The area was divided into 7 regions, 28 zones, 100 subzones in five districts- Junagadh, Amreli, Bhavnagar, Rajkot, and

Porbandar. The area of the census was enlarged because the lions migrated in new areas. The three districts-Junagadh, Amreli, Bhavnagar are the lion districts, as each of them have good number of lion population. Smallest unit of area for counting was beat. Counting in each beat was conducted by a Beat Guard and he was assisted by two persons who knew the area very well. Training for forest officials, staff and persons employed for counting lion was conducted in advance. The experimental or primary counting was done from the afternoon on 24th April to afternoon of 25th April and the final counting was done from the afternoon on 26th April to afternoon on 27th April. The beat guard reported to the sub-zonal officer, the sub-zonal to the zonal officer and the zonal officer to the regional officer and the regional officers to the Chief Wildlife Warden. The counting of the prey was conducted in Gir Conservation Area and the lion distribution range in May 2010. The road count method was applied for estimating herbivore's number. A total of 52490 spotted deer, 4000 sambar, 2895 bluebull, over 290 chausinga, 740 chinkara, 4440 wild boars, 17310 hanuman langur, 22990 peacock were counted in and around Gir Protected Area. In other areas of the lion distribution range, including Girnar and Mitiyala, about 2520 spotted deer, 120 sambar, 20810 bluebull, about half dozen chausinga, 2020 chinkara, 3410 wild board, 350 hanuman langur, 10770 peacock and 300 blackbuck were estimated. The hanuman langur was under estimated because counting was not done in the human habitation. This phase of lion research by WII emphasized the documentation and monitoring of lions outside the PA. With slow colonization of lions outside the PA into the Eastern Agricultural Landscape, lions, both males and females residing in revenue areas were put with transmitters in this phase. Male lions outside the PAs had 3 times the ranges than males inside PA, whereas females had twice the ranges than their contemporary ones inside the PA. Lions fed primarily on Bluebull and domestic livestock outside the PA (Jhala *et al*., 2011). Long term data on demography on lions revealed that population characteristics of Asiatic lions were comparable to that of a much outbred large population of African lions. This showed that although Asiatic lions were inbred, in no way did the inbreeding have had depressive effects on the population as of yet (Banerjee and Jhala, 2012). Radio-telemetry data showed that outside PA, breeding lionesses required a sacrosanct area of about 4 km^2 to breed and rear their cubs (Jhala *et al*., 2011). Hyena ecology project was implemented by Aligarh Muslim University during this time. This was one of the first exclusive work on striped hyena in India. Major objectives of the project were to obtain data pertaining status, food habits, habitat use and den ecology of hyena in Gir. Camera trap based capture-recapture, scat analysis, used-availability method and behavioral sampling on dens was used respectively in order to achieve the results. Camera trapping revealed that hyena exists at a density of 6 individuals/100 km^2 with high densities in eastern part as compared to western part of Gir (Alam *et al*., 2015). Scat analysis revealed a total of 16 food items and Sambar was found to be the dominant species in the diet of hyena (Alam, 2015). Mixed forest was preferred by hyena in terms of habitat preference. Most of the dens and resting sites of hyena were in sandy areas as compared to rocky areas.

Year 2011 to 2015: In order to manage and conserve the Asiatic Lions which are now roaming in over 12000 km^2. Area of Saurashtra peninsula (Asiatic Lion Landscape), different activities were undertaken and public participation was incorporated in the management system. The pioneering *Vanya Prani Mitra* Scheme was introduced in 300 villages of Asiatic Lion Landscape which ensured the involvement of the local villagers in monitoring and conservation of lions. In the PA, the eradication of Invasive Alien Species like *Lantana, Senna*, etc. was taken up on priority basis. Rescue Centres were established and Rescue and Rehabilitation of animals is being efficiently conducted by forest staff and experienced trackers with state of the art facilities spread across the Asiatic Lion Landscape. The Management Plan by Meena and Kumar (2012) is to be implemented for the period from 2012 to 2022 with a focus on Landscape conservation approach through community participation. The objectives proposed under this plan include protection and conservation of the Gir forest, to preserve the diversity of the core conservation unit (Gir National Park and Sanctuary) and maintaining the same by improving health of the forests, their ecological functions, proper water supply, viable prey populations and productivity to their optimum level, management of all segments of *Vidis* (grasslands) as suitable habitats for Asiatic lions and other wildlife like chinkara, blackbuck and to focus on their conservation, maintenance and strengthening of protection measures against poaching, illegal collection of forest produce, forest fires, etc., control and regulate wildlife tourism in the PA, and provision of appropriate interpretation facilities and nature education in order to promote conservation awareness, involvement of people in a participatory manner to strengthen conservation and reduction of negative impacts on biodiversity by providing appropriate eco-development inputs in the villages around Gir PAs through site specific micro-plans, promotion and conduct of ecological research and monitoring studies on all aspects of management. There

Table 1: Population of Asiatic Lions in Gir National Park, Sanctuary and other areas of Asiatic Lion Population Estimate-2015.

S. No.	Area of Habitation	Cubs	Sub Adult			Adult		Total
			Male	Female	Unidentified	Male	Female	
1	Gir National Park and Sanctuary and adjoining areas	84	18	14	0	69	119	304
2	Girnar Sanctuary	11	1	2	0	5	14	33
3	Mitiyala Sanctuary	0	0	0	0	5	3	8
4	Paniya Sanctuary	0	1	1	0	2	7	11
5	South Western Coast (Sutrapada-Kodinar-Una-Veraval)	14	1	1	0	4	12	32
6	South Eastern Coast (Rajula-Jafrabad-Nageshree)	3	2	2	2	2	7	18
7	Savarkundla, Liliya and its adjoining areas of Amreli	24	7	7	7	11	24	80
8	Bhavnagar District	4	2	1	4	11	15	37
	Total	140	32	28	13	109	201	523

has been a considerable increase in wildlife tourism in Gir Tourism Zone, Sasan and Gir Interpretation Zone, Devaliya. In order to reduce the tourism pressure from Sasan, the Ambardi Safari Park and Chikhalkuba Tourism Zone project were approved by the Government of Gujarat. International agencies like The World Bank and Zoological Society of London have implemented various projects viz. Biodiversity Conservation and Rural Livelihood Improvement Project (BCRLIP) implemented for period from 2012-2018 and Partnering to Support Gir Lion Conservation in Gujarat from 2015-2017. The Lion population estimation was carried out in 2015 and recorded 523 lions with growth rate of 27% over previous population estimate, The details of areas of habitation and number of males, females and cubs recorded during the population estimation are given in Table 1. This Estimation exercise was carried out in the 22000 km^2 area of 8 districts of Saurashtra visited by Asiatic Lions, which implies that the species has thus started regaining its lost territory. With the first 2 tier of lion-ecology established, WII in collaboration with the Gujarat Forest Department helped develop a second home for lions in Gujarat. Barda WLS was identified and the potential of this sanctuary for probable reintroduction was assessed. From 2009-2012 second phase of leopard ecology project by AMU was implemented. During this phase major emphasis was give on human-leopard conflict and data pertaining to prey availability, food habits, predation, habitat use and home range of leopards was also collected. Distance sampling shows a substantial increase in densities of prey base of leopard especially of chital, langur and peafowl compared to first phase data. Food habit analysis revealed that leopard diet was dominant with chital and sambar. Leopard was found to be using dense forest more which was consistent with first phase findings. Two individuals were radio-collared during the second phase. Home ranges sizes were small, consistent with phase first findings. Conflict level shows a substantial increase during the last decade. Detailed management guidelines were given to reduce the human-leopard conflict (Khan *et al*., 2013).

Results and Discussion

The glorious history of Gir was not devoid of struggles and problems. The Gir ecosystem and the management have faced several battles in bringing the ecosystem in its healthy condition as seen today. The conservation success stories have not been without dealing and handling with human-wildlife conflict, illicit tree cutting, threats to ecosystem, many have even lost their lives while conserving this pristine ecosystem during these fifty years. Due to the management efforts of over five decades, the population of Asiatic Lion and other wild animals continuously increased, the State Government decided time to time to include the surrounding forests and notified new areas. Hence, the Protected Areas and other surrounding forest areas have increased as wildlife habitat from 1412.13 km^2 in 1965 to 1883.04 km^2 in 2015 (33% increase). Presently over 600 species of plants, 38 species of mammals, 37 species of herpetofauna, over 300 species of birds and over 385 species of insects have been recorded from Gir PA. The herbivore population (Chital, Sambar, Nilgai, Wild pig, Four horned antelope, Langur, Peafowl) has shown a steady increase (Fig. 1).

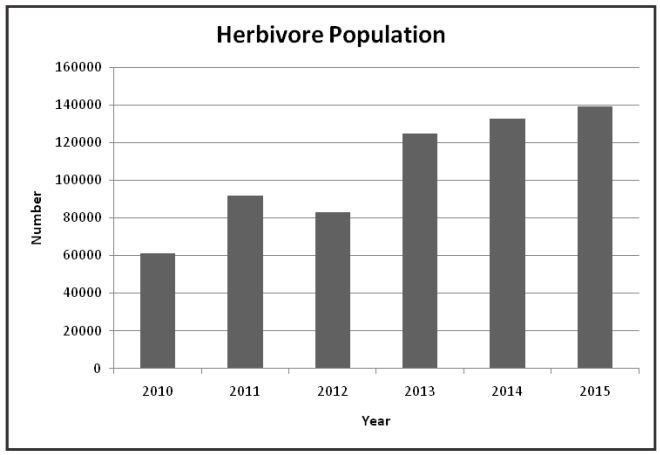


Fig. 1: Increase in the population of herbivores in Gir National Park and Wildlife Sanctuary.

The population of crocodiles has increased from 20 in 1975 to 300 in 2015 at Kamleshwar dam of Gir PA. Various species of wildlife are being rescued in case of health issues, injuries or accidents and rehabilitated after necessary treatment. The number of rescue operations has increased after the facilities being developed all across the Asiatic Lion Landscape with rapid responses. The details of number of rescue operations of lions and leopards during the last 10 years are given in Fig. 2.

The flagship species and target species for management and conservation for the Gujarat Forest Department in this landscape- the Asiatic Lion is reclaiming its lost territory and increasing in numbers (Fig. 3 and 4). The lions are moving and expanding territories in the landscape by use of riverine and non-riverine corridors and are establishing as satellite populations in areas with abundant prey like Bluebull and Wild Boar, water availability and *Prosopis juliflora* thickets for habitat and shelter. The population of Bluebull and Wild Boar in areas where the lions have moved into have drastically reduced and hence the farmers are welcoming the lions in the landscape as their friends since they are controlling herbivore populations.

As a result, the IUCN has updated the category of

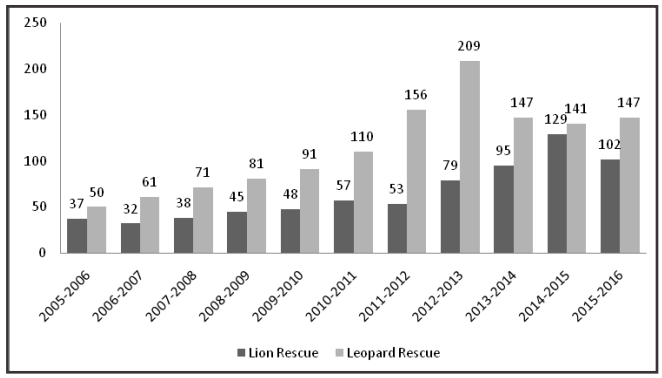


Fig. 2: Number of rescue operations in the past 10 years in the Asiatic Lion Landscape.

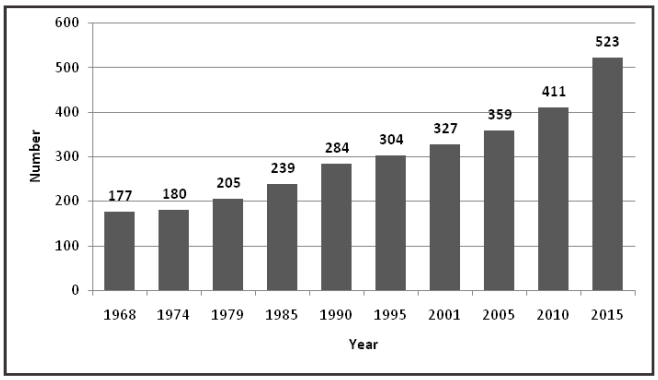


Fig. 3: Population estimates of the Asiatic Lion.

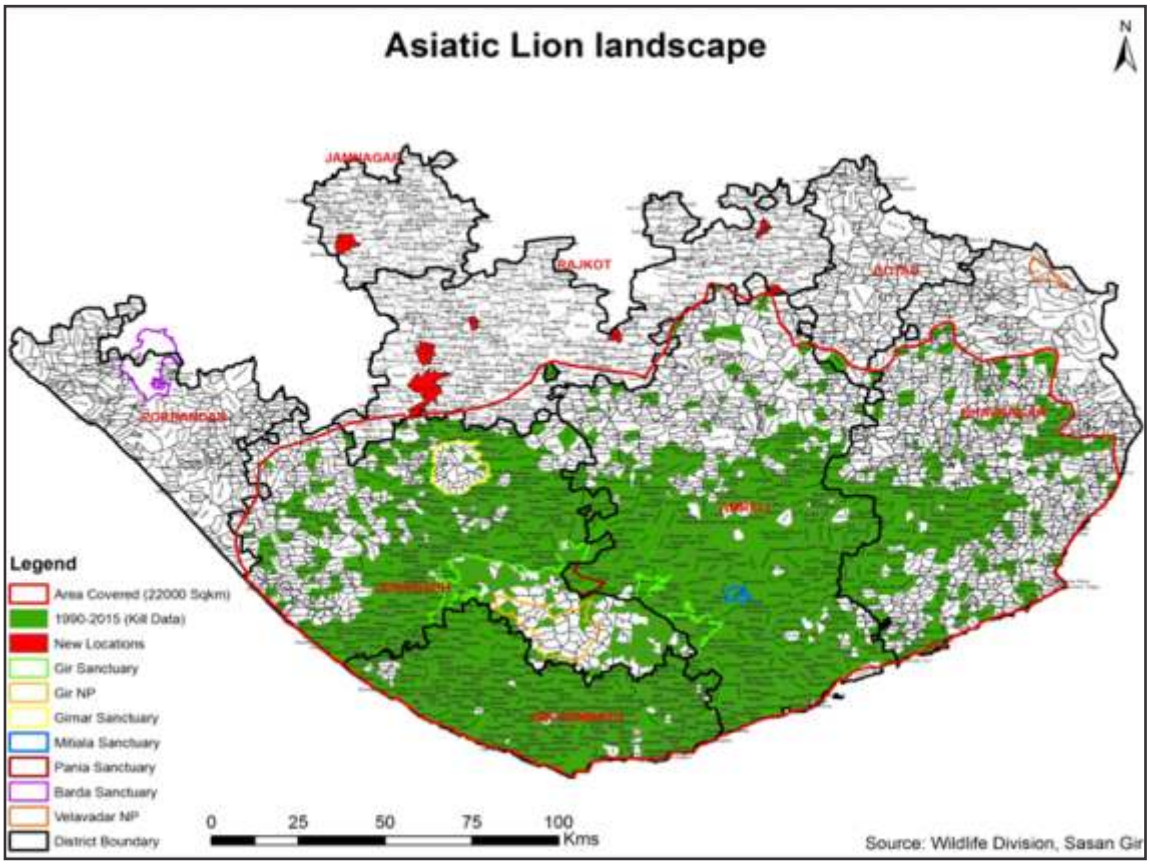


Fig. 4:Increase and spread in the lion occupied habitat in Saurashtra landscape, Gujarat.

the Asiatic Lion as Endangered from Critically Endangered, thus exemplifying the conservation success story of a large carnivore and is acclaimed globally. This tremendous success has been achieved due to the support of the local people and timely management interventions of the state forest department. The recent lion census in 2015 was conducted in an area of about 22000 km^2 of eight districts namely Junagadh, Gir Somnath, Amreli, Botad, Bhavnagar, Porbandar, Jamanagar and Rajkot based on the visitation records including the occasional visits of lions in newer areas. Currently, the area of occupancy of Asiatic lions is about 7000 km^2 and area of distribution is about 12000 km^2 area of Gir Protected Area Network and Greater Gir agro-pastoral landscape. This thus poses major challenges in conserving this carnivore due to increased probability in human-wildlife conflict, threats to the ecosystem due to urban sprawl and other infrastructure development, changing land use patterns, illegal lion shows, etc. Also, the population of leopards in the landscape is increasing, which is resulting in major human-carnivore conflict, which needs to be managed and addressed as the angst in people against the leopard may be detrimental for the lion population in near future. The Gujarat Forest Department continues to strive hard to ensure the long term conservation of the Asiatic lions and is putting efforts in that direction as required by formation of eco-development committees and proposed designation of Community/Conservation Reserves alongwith habitat management and conservation of riverine and non riverine corridors in the landscape for long term wildlife conservation. The goals of management will be amended and addressed as per the needs of the conservation of the core area and as the lions continue to occupy a dynamic multiuse habitat to ensure achievement of continued success in managing and conserving an endangered carnivore, thereby setting a unique example of harmony and human-wildlife coexistence.

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एशियाई शेर (*पेंथीरा लीओ पर्सिका*) : गिर संरक्षित क्षेत्र, गुजरात, भारत में एक संकटापन्न मांसाहारी एवं इसके आवास के संरक्षण के लिए 50 साल की यात्रा

ए.पी. सिंह

सारांश

एशियाई शेर (*पेंथीरा लीओ पर्सिका*) सौराष्ट्र में गुजरात के अर्ध-शुष्क शुष्क पर्णपाती वन भूभागों की एक फ्लैगशिप प्रजाति है। प्रजाति क्रान्तिक रूप से से संकटापन्न थी तथा आवास की क्षति और शिकार के कारण अपने ऐतिहासिक रेंज से यह संख्या में काफी मात्रा में घट गई। पूर्व जूनागढ़ के नवाब द्वारा इनकी सीमा, गिर वन के अंतिम अवशेष पॉकेट में शिकार पर प्रतिबंध लगाया गया। स्वतंत्रता के पश्चात स्थानीय लोगों के सतत् सहयोग के साथ राज्य वन विभाग के सतत् प्रयासों के कारण आबादी को विलोपन से बचा लिया गया और अब संख्या 2015 में 523 तक पहुंच गई है। इसके कारण प्रजाति को आई.यू.सी.एन. की संकटापन्न श्रेणी में उच्चीकृत किया गया है। इससे एक विशाल मांसाहारी की संरक्षण सफलता कहानी का विश्वभर में स्वागत हुआ है एक बार शेर आबादी गिर वन क्षेत्र के करीब 1800 वर्ग कि.मी. तक सीमित हो गयी थी, जिसने अब 7000 वर्ग कि.मी. का क्षेत्र अधिकृत कर लिया है और सौराष्ट्र क्षेत्र, गुजरात के ग्रेटर गिर भूदृश्य के करीब 12000 वर्ग कि.मी. क्षेत्र में वितरित है। इस प्रकार इसने अपना खोया हुआ क्षेत्र पुनः प्राप्त कर लिया है। इस शोधपत्र में एक सक्रिय आवास में दीर्घकालीन संरक्षण सुनिश्चित करने के लिए और उन विभिन्न उपायों एवं कार्रवाइयों पर विचार-विमर्श किया गया है जिन्हें यह सुनिश्चित करने के लिए उठाया गया है कि इस विलक्षण प्रजाति को अपने देशज रेंज में संरक्षित किया जा सकता है।

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