POPULATION DYNAMICS, GROUP STRUCTURE AND NATURAL DISPERSAL OF ASIATIC LIONS

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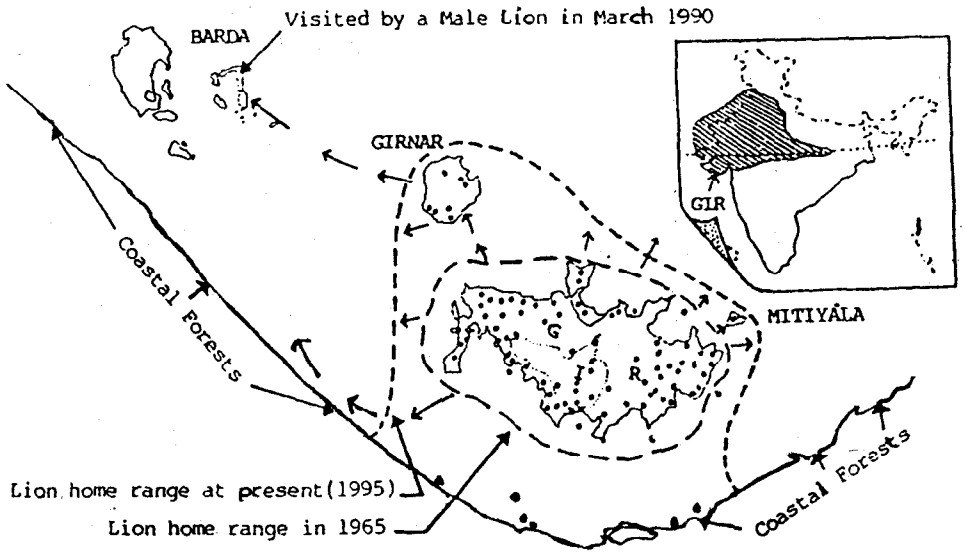
Asiatic Lion and the Gir

The Gir is single largest tract of forests in Saurashtra region of Gujarat State and is synonymous with Asiatic Lion, *Panthera leo persica*. The Lion entered India from Persia at least 6000 years ago and were found in large number in the States of Punjab, Haryana, Rajasthan, U.P., Madhya Pradesh, Gujarat and Western Bihar. The last Lion surviving in the wild outside Saurashtra was killed in 1884.

The old Gir in Saurashtra has shrunk from 3070 km² in 1880s to 1884 km² at present due to expansion of agriculture and destruction of the habitat. In the early part of this century, the Gir was connected with

Fig. 1

ASIATIC LIONS IN THE GIR



Distribution of Lion in India in 19th century and at present

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Girnar, Mitiyala, Barda, Alech hills, Dhank and Chorwad by corridors of rough semi-wooded forests, grasslands and sparsely populated villages. This enabled the lions to move freely in the region.

Lion deserted the Barda and Alech hills towards the later half of the 19th century and disappeared from Girnar and Mitiyala by 1963 and 1955 respectively. At the time of notification of Gir forests as Lion Sanctuary in 1965, lions were found only in the compact forest of the Gir. Gradually, size of wildlife protected area increased to 1412 km^2 with National Park surrounded by Sanctuary. Rest of 403 km^2, peripheral forests constitutes buffer zone of the wildlife reserve.

The most important aspect of the Gir is that it has become a very stable ecosystem with tremendous regenerating, self supporting and sustaining due to its rich and diverse flora and fauna. The Gir is an unique ecosystem which harbours over 400 plants species, 32 species of mammals, 24 species of reptiles, over 310 species of birds, and more than 2000 species of insects along with many micro-flora and fauna.

Conservation Measures to Save Lion

A study by Joslin (1984) revealed that the Gir displayed an overwhelming evidence of accelerated degradation of the ecosystem, and warned that if nothing was done to arrest the rate of decline in number of the surviving Asiatic Lion, the species would be extinct within two decades.

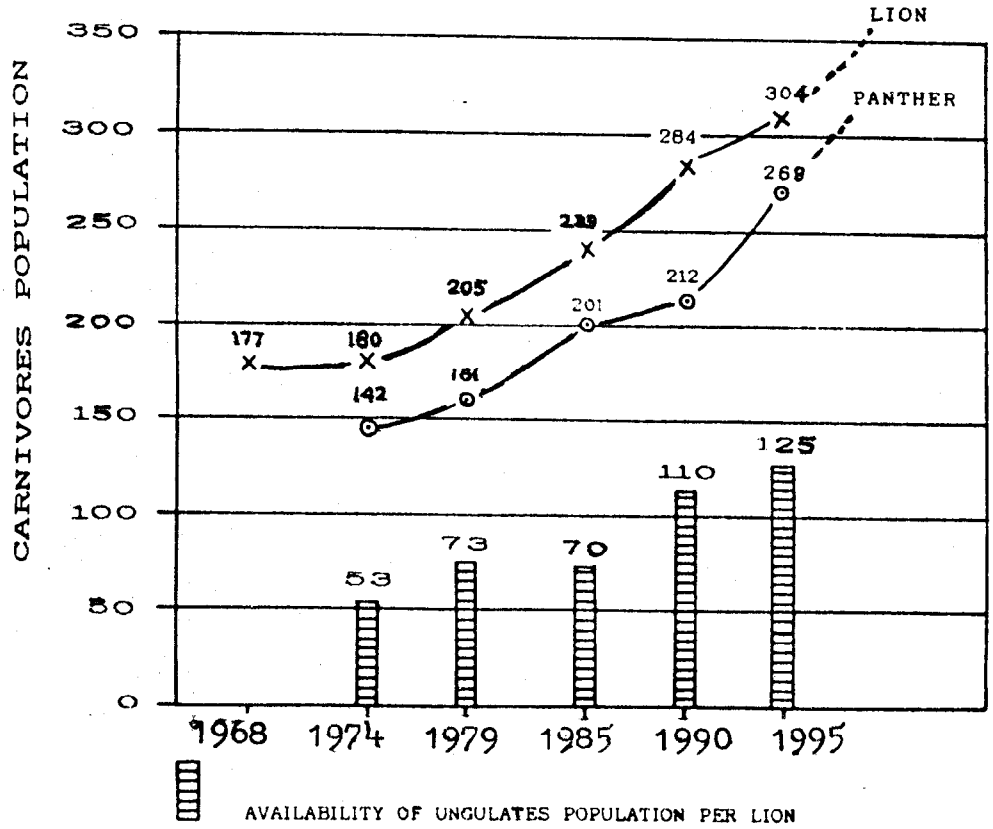
Recognising the serious danger to the Lion and pitiable condition of the maldharis, the Gir Lion Sanctuary Project, a five year scheme was prepared in 1972 and same was implemented at a total cost of Rs. 58 lakhs. The works carried out under the project were : (1) fencing of sanctuary through constructing rubble wall in 400 km along periphery, (ii) constructing barricades along the water course traversing the periphery of the sanctuary, (iii) establishing check posts with barriers across all the public roads passing through sanctuary, and (iv) shifting of all Maldhari families from National Park and majority of families from the sanctuary, and resettling them outside the sanctuary by allotting cultivable lands, grazing land and house sites. Out of 845 Maldhari families, about two-third have been settled outside at different sites.

Serious problems like grazing, poaching, lopping, illicit cutting etc. could be tackled by the Forest Department and development programmes like soil and moisture conservation, habitat improvement, plantation etc. were implemented during the period. Degradation of Gir ecosystem could be reversed and habitats improved in the park and sanctuary. Many parts of the Gir have become dense since the launching of the project. Construction of Water harvesting structures and artificial water holes has increased the availability of water to the wildlife.

Increase in Wildlife Population and Change in Food Pattern

The Gir habitat has improved since declaration of sanctuary and implementation of the Gir Lion Sanctuary Project which has resulted into increase in availability of food and water. Six consecutive censuses have been conducted at interval of five years since declaration of the sanctuary, and population of Lion along with other wild animals have increased consistently. Figures of last six censuses

Fig. 2



Growth of wildlife population in the Gir

are given in Table 1.

Herbivores in above table include only six major species i.e. Chital, Sambar, Blue Bull, Chinkara, Four Horned Antelope and Wild Boar. There has been consistent increase in carnivores and herbivores. Availability of ungulates number per Lion has increased from 53.5 in 1974 to 125.7 in 1995 which makes easily available wild kills for carnivores.

Ungulate habitat relationship in Gir has been studied by Berwick (1974). Chellam and Johnsingh (1993) have investigated the Gir ecology and behaviour of the lions. At least 75% of the Lion food came from livestock, mainly buffaloes and 25% from the wild herbivores. Gradual positive development took place during last two decades and ungulates population increased more than five folds. The study of Chellam and Johnsing (1993) indicated that food pattern of Lion has changed in favour of wild prey as 65% of Lion diet was recorded from wild animals whereas 35% was supplemented through livestock kills.

Table 1

Growth of Wildlife population in the Gir

Year	Lion	Leopard	Hyena	Herbivores (ungulates)	No. of ungulates per Lion
1968	177	NA	NA	NA	NA
1974	180	142	63	9635	53.5
1979	205	161	84	14964	73.0
1985	239	201	192	16905	70.7
1990	284	212	97	31489	110.9
1995	304	268	137	38221	125.9

Group Structure and Size

Lions are social animals with strong family ties and they usually live and hunt in family groups. Size of groups recorded in the Gir was large in the past because live baits were provided for Lion show. This practice was stopped in 1987 and group size above a dozen is seen rarely at present.

304 Lions were located at 94 sites on live baits during last day of Lion census in May, 1995 against 284 Lions at 59 locations in 1990. All grouping were natural except a group in Babara Zone in which two-three groups of same pride merged to form a big group of 15 at bait site. Different types of composition of groups recorded during the census are given in Table 2.

Following findings have emerged after analysis of census data.

1. Single males were observed at 15 sites which was maximum location among five types of group structure. Pure male groups were found in single or pair except one location where three males came to bait site.
2. Location sites for single male, two males, single female, and pair were largest among different types of group structure.
3. Single females were located at seven sites and some of them were very old.
4. Most of male, female pairs were mating pairs of sub-adults.
5. Large groups of animals were found in mixed groups with one male and a few females and cubs.
6. Pure group of males was not seen with any cub.
7. Average group size of animals in May, 1995 (Anon., 1995) census was smaller than the size recorded during census in May, 1990 (Anon., 1990).
8. No. of Lion locations increased from 59 in 1990 to 94 in 1995.

Live baits may have caused artificial grouping at a few sites but such grouping was mostly limited among animals which normally share food at kills.

Table 2

Group Structure of Asiatic Lion observed during last two censuses

Group Composition	May, 1995			May, 1990		
	No. of animal	Av. group size	Range of group size	No. of locations	Av. group size	Range of group size
Pure Male	33	1.42	1-3	24	1.40	1-3
Pure Female	17	1.55	1-3	11	1.38	1-2
Male and Female	87	3.37	2-8	26	4.62	2-11
Female and Cub	73	4.05	2-9	18	6.75	4-10
Mixed group (Male, Female and cubs)	94	6.27	3-15	15	11.3	3-28
Total/Average	304	3.23	1-15	94	4.81	1-28

Natural Dispersal/Migration of Lions

Lions disappeared from neighbouring forests outside the Gir during middle of this century. Habitat of the Gir has improved and Lion population grew gradually with increased level of protection and conservation. Before census in 1990, lions were occasional visitors to Girnar, Mitiyala and Coastal forests but they started visiting neighbouring forests again. Situation has changed since then and this carnivore started capturing its lost territories. Prides of lions have occupied Girnar, Mitiyala and coastal forests permanently. At present, there are four satellitic population of Lions and second generation of migrated Lion has made Girnar and Coastal forests as home range. Dispersal paths of the Asiatic Lion at present are almost similar to extinction path adopted during the beginning of this century and may follow same trend further till they reach other new areas.

It has been observed that majority of migrated Lions were sub-adult, probably they were compelled by dominant male to leave the pride and territory. Wild Lions in Girnar were often attracted by the roaring of captive Lions kept in the Sakkarbaug Zoo maintained by the Forest Department on the outskirts of Junagadh town in 1950 (Rashid and Reuben, 1992). This is repeated after 40 years as two male Lions regularly visit spacious Lion enclosure constructed recently in the adjacent forest for breeding programme. 4 Lions were recorded in 1990 which has increased to 13 as per census conducted in May, 1995.

Strip of long coastal plantation support small population of Blue Bull and Wild Boar. One pride of 16 Lions in Kodinar, Dhamrej Sutrapada and another of 10 Lions in Rajula and Jafarabad depend on cattle and blue Bull. Lions were brought back to the Gir in the past but they repeatedly migrated to coastal forests in search of food and territory and settled permanently in these areas after 1990. Fourth satellitic population of Lions is in Mitiyala forests of Bhavnager Forest Division, which is in the process of settling there permanently. Distribution of Lion population in Gir and extended Gir is given in Table 3.

Table 3

Distribution of Lions in different areas, Lion Census May, 1995

Site	Lion Population			
	Male	Female	Cubs	Total
Gir	92	100	61	262
National park	10	12	9	31
Sanctuary	72	92	50	214
Peripheral forests	10	5	2	17
Girnar	10	3	-	13
Mitiyala	2	1	-	3
Kodinar-Sutrapada Coastal forests	5	6	5	16
Una-Rajula-Jafarabad Coastal forests	3	2	5	10
	112	121	71	304

Table 4

Population of Wildlife in the Gir Wildlife Census May, 1995

Species	Population
Lion	304
Leopard	268
Hyaena	137
Chital	32061
Sambar	2262
Blue Bull	1856
Four horned Antelope	441
Chinkara	387
Wild Boar	1214
Monkey	2493
Pea Fowl	41965

Lions number outside Gir is floating population because some of them visit above zones for short period and come back to the original areas. Table 3 indicates that 42 Lions including 10 cubs stay outside the Gir and also indicate that population of Lion staying outside the PA may keep on increasing under existing protection level.

All four sites have low herbivores number and migrated Lion primarily depend on domestic livestock kills. Trend of dispersal of Lion still continues, as a Lion made a kill in grass vidi near Barda forests in 1990, and stayed there for 36 days. If this trend continues, growing population from the Girnar and coastal forests may reach new areas in Saurashtra. In Barda forests, only improved prey-base and habitat might attract the Lions to make this area as another home for Asiatic Lion.

Carrying Capacity of the Gir

Carrying capacity of an area depends on availability of food, water, sex and space. There is a scope for improvement of habitat to increase the herbivores population. Food is not a major limiting factor in the Gir as population of important ungulates increased at rate of 14.2% per year during last three decades but shortage of space may result into territorial fighting and migration. Population of the animal has remained

almost at same level (267 in 1990 and 262 in 1995) in the National Park and Sanctuary during last two censuses. Positive changes in the habitat may improve this figure marginally but growing population of the big cat can be managed through improving habitats in new areas naturally opted by the Lions.

Natural dispersal of lion started after last drought in 1987. 17 Lions were recorded outside the Gir in 1990 which has increased to 42 in 1995 but number of the animal remained constant in the PA during last two censuses. Thus, present level of Lion population within PA may be the carrying capacity of the park and sanctuary.

Need for Conservation Strategy

Lion is a key indicator species which should decide ecological boundary of the Gir. In background of this reality, concept of management of Greater Gir Ecosystem or extended Gir in new territories of Lions has become necessity of time in the interest of nature conservation and management of increasing Lion population. Proper strategies should be designed for management of following forests along with grasslands, wastelands to expand Gir forests from 1814 km^2 at present to 2370 km^2 in near future by covering Girnar (179.5 km^2), Mitiyala (19.4 km^2), Coastal forests (110.1 km^2), Barda (187.4 km^2), and Vidis (approx. 60 km^2). In addition to the forest lands, wastelands, and Panchayat lands, connecting Gir and above forests, should be developed and managed as corridors for Lion, and entire forests of Junagadh and Amreli Districts should be managed as Greater Gir Forests under a unified administrative set up.

Following measures are required to be adopted as a part of management strategy :

1. Habitat of the Gir should be improved and expanded through arresting the degradation of peripheral forests and wastelands.

2. For a better life outside the sanctuary, facilities should be created to attract those maldharis who are residing inside the sanctuary without basic facilities.

3. Satellitic population at four sites should be managed by increasing prey base.

4. Girnar and coastal forests should be conserved and herbivores population should be increased to meet the requirement of growing population of the Lions.

5. Barda forests, which was selected as an alternative home for the Lion in 1979 should be rehabilitated and prey base should be increased through taking up breeding programmes of herbivores.

6. For herbivores *in-situ* breeding programme should be developed for increasing the ungulate population in the Girnar, coastal forests and Mitiyala forests.

7. Necessary management practices should be followed to facilitate natural migration of Lions in new area. Problem animals should be removed from wild population and these should be utilised for breeding purpose in zoos.

8. Management of Girnar, Barda, Mitiyala, coastal forests and other neighbouring forests should be integrated with management of the Gir and concept of the Greater Gir Ecosystem Management

should be evolved, not only for conservation of the Asiatic Lion but also to provide ecological security to the region. Management of wasteland, panchayat lands, grasslands and forests connecting Gir to new habitat should be covered under a management plan for Greater Gir Ecosystem.

SUMMARY

Gir forest in Saurashtra region of Gujarat is synonymous with Asiatic Lion. Recognising the serious danger to the Lion and pitiable condition of Gir Maldharis in 1972, the Gir Lion Sanctuary Project was implemented for five years which resulted into improvement of habitat and wildlife. Lion number increased from 177 in 1968 to 304 in 1995. Availability of major ungulates increased from 53.5 ungulates per lion to 125.9 ungulates per lion. Studies indicate that food pattern of lion has changed in favour of wild animal from 25% in 1972 to 65% in 1990. Improvement of the Gir forests and increase in wildlife population have brought major change in social behaviour and reduction in size of groups of lion. Asiatic Lion started migrating from Gir forests to neighbouring forests in search of food and space. Dispersal paths of the Asiatic Lion at present are almost similar to the extinction path adopted during the beginning of this century. There are four satellitic population of lions in Girnar, Mitiyala and Coastal forests outside the Gir. It has become necessary to expand present Gir forests to new areas by covering Girnar, Mitiyala, Barda, Coastal forests, grasslands to manage increasing lion population as well as maintaining ecological security of the region.

एशियाई सिंहों की संख्यागतिकी, वर्ग संरचना और प्राकृतिक विकिरण

एच० एस० सिंह

सारांश

गुजरात के सौराष्ट्र प्रदेश के गीर वन एशियाई सिंहों के पर्यायवाची ही हो गए हैं । गीर के मालधारियों की दयनीय दशा और सिंह को विलुप्ति का भारी खतरा आया देखते हुए 1972 में पाँच वर्ष के लिए गीर सिंह अभयारण्य परियोजना क्रियान्वित की गई जिससे वन्य प्राणियों और उनके प्राकृतावास में सुधार हुआ । सिंहों की संख्या में वृद्धि 1968 में 177 से बढ़कर 1995 में 304 हुई । सिंहों की संख्या प्रति सिंह 53.5 खुर वाले पशुओं से बढ़कर प्रति सिंह 125.9 पशु हो गई । अध्ययनों से पता चलता है कि सिंहों की भोजन सज्जा 1972 में 25% जंगली पशु से बदल कर 1990 में 65% पशु हो गई । गीर वनों और उनमें रहने वाले वन्य पशुओं की संख्या बढ़ने से उनका समाजिक व्यवहार भी बहुत बदला है और उससे सिंहों के वर्गों का आकार घट गया है । खाने और स्थान की खोज में एशियाई सिंह गीर वनों से आस-पास के वनों में जाने लगे हैं । एशियाई सिंहों द्वारा अपनाया गया विकिरण मार्ग इस समय लगभग वही है जिसे उन्होंने इस शती के प्रारम्भ में अपनी विलुप्ति के समय अपनाया था । गिरनार, मितियाला और गीर से बाहर सागर तटीय वनों में साथ लगे हुए सिंहों के चार संख्या-बहुल क्षेत्र हैं । इसलिए सिंहों की संख्या का प्रबन्ध करने और इस क्षेत्र की पारिस्थिकीय सुरक्षा बनाए रखने के लिए गिरनार, मितियाला और सागर तटीय खास भूमियों को साथ मिलाते हुए वर्तमान गीर वनों को नए क्षेत्रों में बढ़ाना आवश्यक हो गया है ।

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Snippets PLANT LOCATION

A computer program has been developed that selects optimal OSB plant location and size based on cost minimization. The program, OSB/LOCATION, has two features that make it different from other optimal-location programs. First, the solution is the optimal combination of plant location and size. Second, the program can provide the best alternative solutions in addition to the optimal solution (or multiple solutions). Alternative solutions provide the decision maker with more flexibility when other factors, such as community life quality and political preference, have to be considered. With snall modifications, this program can be used for planning other forest product manufacturing facilities such as laminated veneer lumber plants, medium density fibre-board plants, or sawmill. For further information contact Ken J. Muehlenfeld, Forest Products Development Center, School of Forestry, Auburn Univ., Auburn, AL 36849-5418.

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