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Estimation of the Status of Asiatic Lion (*Panthera leo persica*)

Population in Gir Lion Landscape, Gujarat, India

Carnivore conservation necessitates their population estimation. Owing to the elusiveness of carnivores that precludes direct observations, their population estimation is primarily a difficult task. The only population of Asiatic lion is found in the Gir forests and its adjoining landscape of Gujarat, India where under the strict and stringent protection of the erstwhile Nawab of Junagarh and subsequently the State-run Forest Department, their numbers have bounced back from the brink of extinction. At present 523 individuals live encompassing a total area of over 7000 km^2 in the Gir and Greater Gir landscape in Gujarat, Western India. Asiatic lions are among the few large carnivores which have been managed and counted since a very long time. In this paper, elucidation of the history of population estimation of lions in the Gir forests, and put forth a new- management oriented yet scientifically robust technique of enumerating the status of Asiatic lions, an endangered carnivore nurtured and scientifically managed since 5 decades.

Key words: Asiatic lion, Population estimation, Gir landscape, Endangered.

Introduction

Out of 8 globally known sub-species of lions, Asiatic lion (*Panthera leo persica*) is only surviving in the Gir forests of Gujarat in India. Large carnivores have always been a source of fascination for people and our relationships with them vary from awe and inspiration to fear and loathing (Minta *et al*., 1999). The world today is probably witnessing the highest concern that the society has ever shown towards the conservation of large carnivores and their ecosystems (Mech, 1996). Nevertheless, recent assessments of the conservation status of carnivores present an alarming global picture of ongoing declines and range contractions (Treves and Karanth, 2003). Certain k-selected traits inherent to large carnivores such as body size, complex social behaviour, low population density, specialized niche requirements, high trophic level and large home range size coupled with severe threats from habitat fragmentation and poaching have resulted in local extinctions, isolation and range contraction from most areas (Wilcox and Dennis, 1985; Woodroffe and Ginsberg, 1998). The situation has become more worrying in a country like India chiefly due to an agrarian economy. Intensive trophy hunting of large mammals before independence of India (1947) and tremendous socio-political pressures to improve lives of millions after independence have decimated ranges of many carnivores in the country. The population size of large carnivores is a good indicator of varying ecological factors. However, owing to their elusiveness that precludes direct observations, estimating their abundances are often difficult (Schaller, 1967). Low densities, wide ranging and cryptic nature of carnivores often demands extreme high resources for abundance estimation (Garshelis, 1992). Nevertheless, several approaches have been tried for estimating large carnivore numbers. These include total counts without correcting for detection bias (Choudhury, 1970; Fuller, 1989; Gore *et al*., 1993; Smallwood and Fitzbugh, 1995), indices for relative abundance (Knowlton and Tzilkowski, 1979; Palomares *et al*., 1996; Stander, 1998; Houser *et al.,* 2009; Funston *et al*., 2010), indirect methods of scaling and predicting (Carbone and John, 2002; Karanth *et al*., 2004; Hayward *et al*., 2007) and modern

Out of the total 523 lions encompassing a total area of over 7000 km^2 in the Gir and Gir landscape in Gujarat, 268 lions from Junagarh, 174 from Amreli, 44 from Gir Somnath and 37 lions from Bhavnagar district were recorded.

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approaches to abundance estimation incorporating detection probabilities (Karanth and Nichols, 1998; Grogan and Lindzey, 1999; Soisalo and Cavalcanti, 2006).

Conservation of Gir lions 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 due to hunting and habitat loss (Joslin, 1973). A single population of less than 50 lions persisted in the Gir forests of Gujarat by late 1890s (Divyabhanusinh, 2005). With timely and stringent protection offered by the Nawabs of Junagarh and subsequently by Gujarat State-run Forest Department (GFD), Gir lions have increased to the current population of over 500 with an annual rate of about 2% during past six decades (Fig. 1 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 to occupy over 7000 km^2 of human-dominated agro-pastoral landscapes of Saurashtra peninsula (Singh, 2007; Gujarat Forest Department, 2015). After the formation of the Gujarat State in 1960, the Gujarat Forest Department has been estimating the lion population five yearly by adopting the prescribed methodology. The first round was in 1963 based on "Pug Mark" count estimation and efforts were made to mark individual animals by colour. The method consisted of baiting lions across Gir with buffalo calves, thus making them stationary for a period of 3-4 days and then conducting a total count of all lions simultaneously. The Gujarat Forest Department had been using this method since 1968 till 1995 *i.e.* six population assessments (Dalvi, 1969). This method evolved from the time of the erstwhile Nawab of Junagarh since the lion numbers were very low and trackers were employed to continuously track each individual animal to keep a check on their health, movement and other behavioural traits. The trackers were capable of identifying each individual lion on the basis of identification marks and their behaviour and were so closely associated with the lions, that they could give names to some of them *viz*. Bhagat, Maulana, Ram, Shyam, Rajmata, etc. The method was however, objected by the judiciary on the grounds of prevention of cruelty to animals (buffalo baits) in the year 2000. In the year 2000, lion population was estimated based on the method of direct counts at water points systematically across all Forest Beats (smallest management unit in the PA).

Material and Methods

Study area

The population estimations are being carried out in Gir and Greater Gir landscape from 1905 to 2015 in the state of Gujarat, western India. The Gir Landscape is amultiple land-use area composed of the 1,883 km^2 Gir Protected Areas (Gir PAs) and surrounding forests and human-dominated agro pastoral landscape of Amreli, Bhavnagar, Junagadh and Gir-Somnath districts. Presently the lions occupy an area of 7000 km^2 and are distributed in 12000 km^2 of Gir and Greater Gir landscape. The Gir Landscape is a typical biogeographic representative of the semiarid Gujarat–Rajputana Zone, located between the coordinates 21.835^{0}N, 70.828^{0}E; 21.807^{0}N, 70.828^{0}E; 21.847^{0}N, 72.802^{0}E; and 21.808^{0}N, 71.859^{0}E.

Population estimation

Lot of resources and management inputs are invested in protecting the habitat and the Asiatic lions. In such circumstances it is imperative to know their population status and trends to gauge the success of conservation investments. Estimating wide ranging cryptic species that occur at inherent low densities is immensely difficult. With the advancement of scientific approach in the field of Nature Conservation and unification of Lion habitats under one State administration during the post Indian independence period, methods for estimation were improved and area coverage was defined and more reliable population estimations were made. Within the forested part of the landscape, the forest beats were delineated as sampling units while in the agro-pastoral and rural and part of the landscape, a cluster of village lands were predetermined to constitute sampling units. Summer (April-May) is the best time to conduct this exercise as number of natural water sources are limited, better visibility due to scarce vegetation cover and fullness of the moon is taken into account. The preparations included collection of data on lion movement and on composition of prides in the landscape. Data was collected from all divisions where there was possible movement of lions as kill data, direct lion sighting data, indirect data as pugmarks and on basis of scats collected from field and also collected data from historical records of movement of lions. Other than the officials of forest department, experts from various fields and persons who have worked in field of lions and had vast experience of lion management and their pride behavior were designated as observers. Also people from various other fields, NGOs were involved as volunteers to make the whole census exercise more transparent. The lions of Gir are completely different from wild tigers and leopards. The behavioral difference recorded by M.K. Ranjitsinghji in the context of artificial feeding, does reveal certain patterns of behavior of some species in the proximity of human beings. In no circumstances or with any amount of incumbent could the tiger and leopard ever be made to match the “incredible confidence that the Gir lions now exhibit to the close proximity of man on foot”. The Asiatic lion is a social and territorial animal and male lion lives in male coalitions and with prides of females and cubs and protects his territory by fighting with other males. To record and verify individual animals, different datasheets (see supplementary information) were prepared which were filled by the observers and enumerators. Lions and other wild animals need to drink at least once daily, this phenomenon makes it comparatively easy to decide probable places to locate the animals at different water holes. Such available water sources and probable places are surveyed during pre-census exercise. It was made mandatory to take pictures of all animals whether alone or in group. GPS locations of all individual animals and groups are taken and also time of count was noted in the format. In the forms, portrait of male and female adult lions were also given and it was directed to enumerators and observers to mark different types of prominent marks and scars as cut on face, ears, nose, on chick whether right or left which have been found to be distinguishing

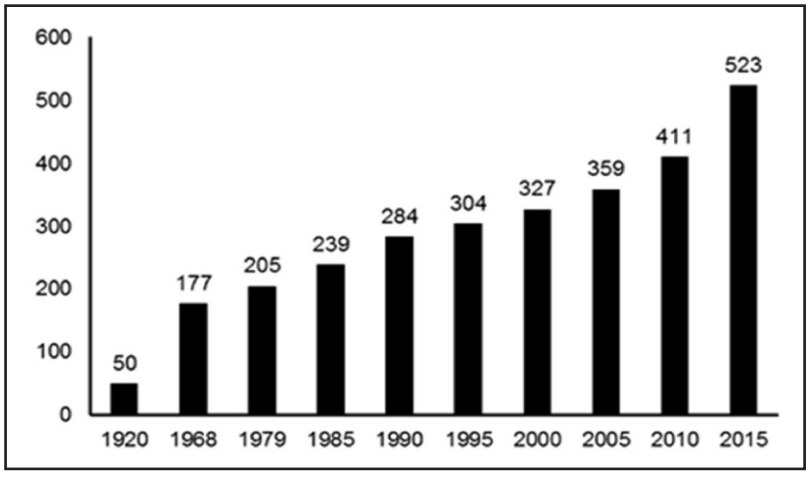

Fig. 1: Population trend in Gir lion since 1920 (Source- Gujarat Forest Department Census Reports and present study).

Table 1: Break-up of lion population in all the estimations (different age and sex classes).

Year	Adult		Sub-adult			Cubs	Total	Authority
	Male	Female	Male	Female	U			
1936	143	91	-	-	-	53	**287**	JDS
1950	179	187	-	-	-	40	**219 to 227**	WB
1955	144	100	-	-	-	49	**290**	WB
1963	82	134	-	-	-	69	**285**	GFD
1968	60	64	-	-	-	51	**177**	GFD
1974	40	52	13	25	-	50	**180**	GFD
1979	52	68	13	14	-	58	**205**	GFD
1985	66	75			-	48	**239**	GFD
1990	99	95	-	-	-	63	**284**	GFD
1995	94	100	18	21	-	71	**304**	GFD
2001	101	114	20	18	19	55	**327**	GFD
2005	89	124	-	-	72	74	**359**	GFD
2010	97	162	23	23	29	77	**411**	GFD
2015	109	201	32	28	13	140	**523**	GFD

U = Unidentified, JDS = Junagadh State, WB = Wynter Blyth, GFD = Gujarat Forest Department

factors among lions as they get these marks mainly during in-fights in males and during mating among females once healed these marks remains for ever on their faces an are easy to be identified by the field staff. Direction of movement of animal and time and group composition along with the distance they have moved was taken in consideration to remove the duplication. As the direction and time at which animal started moving and then approximately how much distance has been travelled in that direction along with group composition and identification marks helped up to perfection to remove the duplication of lions during final analysis using GPS locations plotted on a map using GIS software and tools.

Based on surveys and collection of data on presence of lions the whole area to be included incensus was then divided in 8 regions during the recent census 2015, experienced officers of the rank of Chief Conservator of Forests (CCF) and Conservator of Forests (CF) were appointed as Regional Officers and each region is divided in to zones. So there were 30 zones each headed by a

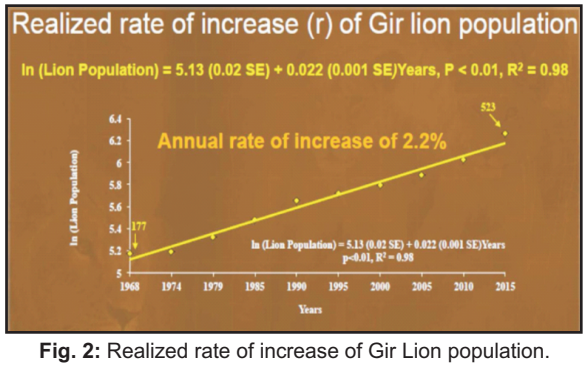

Fig. 2: Realized rate of increase of Gir Lion population.

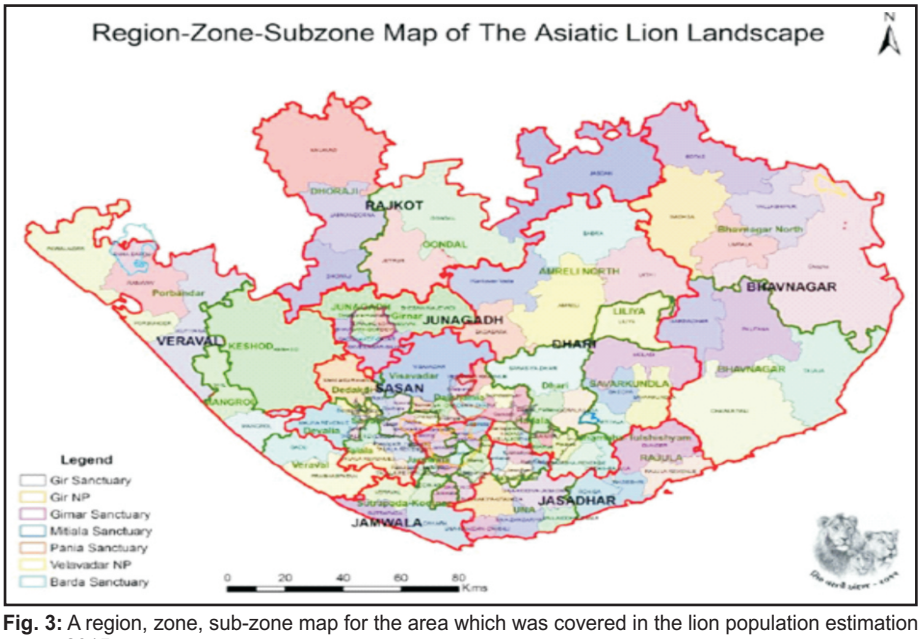

Fig. 3: A region, zone, sub-zone map for the area which was covered in the lion population estimation 2015.

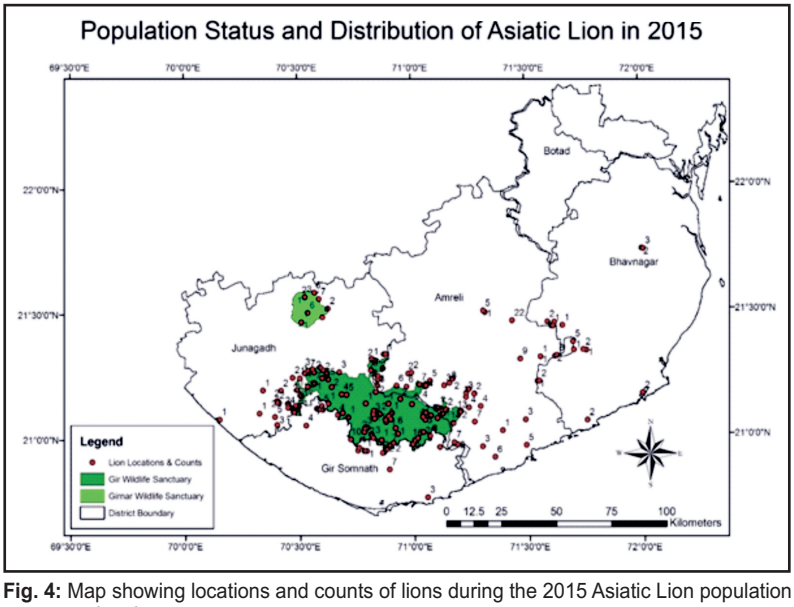

Fig. 4: Map showing locations and counts of lions during the 2015 Asiatic Lion population estimation.

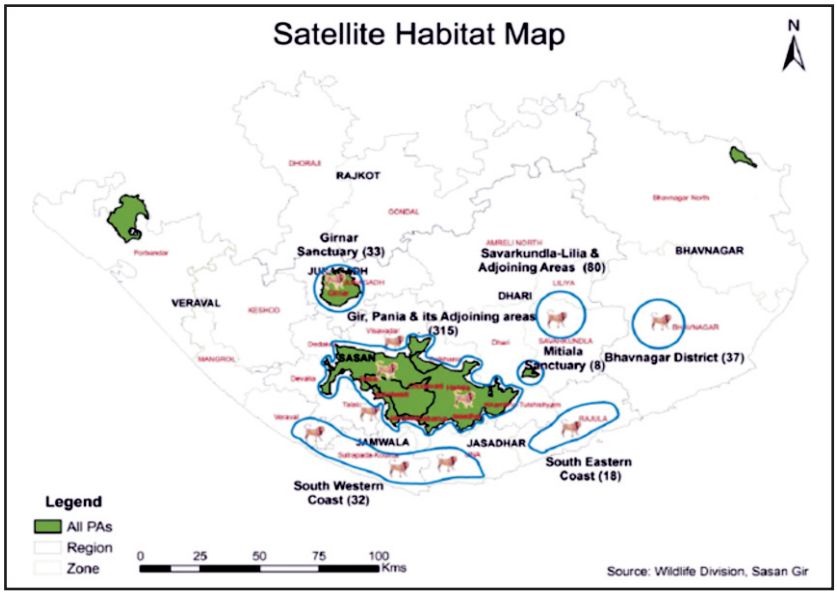

Fig. 5: Major lion populations and their numbers within the Gir landscape.

forest officer of the level of Deputy Conservator of Forests (DCF) or CF rank and then each zone in to sub zone. There were 106 sub zones which were supervised by officer of the level of Assistant Conservator of Forests (ACF)/ Range Forest Officer (RFO) rank and then each sub zone is divided into sample units. There were 625 sample units and each sample unit had one enumerator who happened to be a forest official and volunteers were appointed in sample units as observers. Asiatic Lion Landscape was divided in 8 regions, 30 zones, and 106 sub-zones for the Lion Population Estimation 2015 (Fig. 1 and 3).

Population trend

The trend in the population growth for lions was estimated by regressing the natural log transformed values from the population estimation with respective years. This gave the intrinsic growth rate of the population (Fig. 2).

Results

While the distribution of lions has consistently shrunk and has been limited to a single pocket in Gir, the population numbers within the area has also fluctuated widely over the years. Once the number of lions in the Gir was very small. Between 1880 and 1900, lion population was estimated by various authorities; but their accuracy and area of estimation was not clear. Lion counts in the following years, in 1950, 1955 and in 1963 estimated the population to be 227, 290, and 285 respectively (Wynter-Blyth and Dharmakumarsinhji, 1950; Wynter-Blyth, 1956; Singh, 1997). The population of lions has since shown a steady increase (Fig. 1 and Table 1). The 14th Asiatic Lion Population Estimate, conducted in 2015, in the sprawling expanse of “Asiatic Lion Landscape,” including areas outside the Gir National Park and Sanctuary. The lion numbers have almost doubled since 1979. The 2010 census had pegged the population at 411, but with an increase of 112 animals in the next five years and the lion population now stands at 523 from four districts of Saurashtra. The increase in lion population between 2005 and 2010 was 14.48 %, while in 2010 and 2015 the lion population has increased by over 27.25 %, which is the highest ever raise. 109 were adult male and 201 were adult female, 140 were cubs less than a year old, and 73 in the 1-3 years age group (Table 1). A significant proportion of the lion population comprises young ones, which bode well for the future. Out of total, 268 lions were recorded from Junagarh district, 174 lions from Amreli district, 44 Lions from Gir Somnath District and 37 lions were recorded from Bhavnagar district. The locations and the total counts of all individual lions during the Asiatic Lion population estimation of 2015 is shown in fig. 4.

Discussion

Today lions are present in Gir National Park and Sanctuary and its surrounds viz. Girnar Sanctuary, Mitiyala Sanctuary, Pania Sanctuary, South Eastern and Western coastal areas, Savarkundla, Liliya and adjoining areas of Amreli and Bhavnagar Districts (Fig. 5). However, we do recognize the limitations of total counts of carnivores, but an attempt was made by the Wildlife Institute of India to use whiskers pattern technique in a mark-recapture framework to count and identify lions in 2001 census and the number if we compare with total count method in the same year shows no significant difference (The total count number falls in 95% confidence level as shown by Jhala *et al.,* 1999).The technique proved to be significant in case of lions which has different behavior then other cats (as beingmore social and adopt to human behavior than other big cats) and has shown considerable results since it was adopted in 2001. This technique was possible only because of the familiarization of the forest department staff with the lions, a practice since the days there were a handful of individuals of this charismatic sub-species. The technique can be used for counting of other cats also and can show significant results with pre surveys and collection of data on kills and direct and indirect signs of presence of cats in a region along with other technical aids.

गिर शेर भूदृश्य, गुजरात, भारत में एशियाई शेर (*पैन्थीरा लीओ पर्सिका*) आबादियों के स्तर का आकलन

ए.पी. सिंह एवं राम रतन नाला

सारांश

मांसाहारी संरक्षण ने इनकी आबादी आकलन को अनिवार्य बना दिया है। मांसाहारियों की दुर्गाहयता, जो प्रत्यक्ष प्रेक्षणों में बाधा डालता है, के कारण इनकी आबादी का आकलन करना मुख्यत: एक कठिन कार्य है। एशियाई शेरों की आबादी केवल गुजरात, भारत के गिर वनों तथा इसके समीपवर्ती भूदृश्य में मिलती है, जहाँ जूनागढ़ के पूर्व नवाब तथा बाद में राज्य संचालित वन विभाग को सख्त एवं कड़ी सुरक्षा के अन्तर्गत इनकी संख्याएं विलोपन होने की कगार से बाहर आई। वर्तमान में 523 एकल गुजरात, पश्चिमी भारत में गिर तथा वृहत्तर गिर भूदृश्य में 7000 वर्ग कि. मी. से अधिक के कुल क्षेत्रफल में मौजूद हैं। एशियाई शेर कुछ विशाल मांसाहारियों में से हैं, जिन्हें बहुत लम्बे समय से प्रबंधित किया गया है तथा गणना की गई है। इस शोधपत्र में गिर वनों में शेरों के आबादी आकलन के इतिहास का स्पष्टीकरण दिया गया है तथा पांच दशकों से पोषित एवं वैज्ञानिक रूप से प्रबंधित एक संकटापन्न मांसाहारी एशियाई शेरों के स्तर की गणना करने के विषय में एक नयी प्रबंधोन्मुखी वैज्ञानिक रूप से संतुलित तकनीक बताई गई है।

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